ST. THOMAS COLLEGE (AUTONOMOUS)
THRISSUR

Affiliated to
UNIVERSITY OF CALICUT

SYLLABUS FOR DEGREE OF

B.Sc. STATISTICS HONOURS
(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS
w.e.f. 2024 admission onwards

St. Thomas College Four Year Under Graduate Programme
[STCFYUGP]

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Ms. Ashlin Mathew	Assistant Professor, Department of Statistics, St. Thomas College (Autonomous), Thrissur

VISION, MISSION & CORE VALUES

MOTTO:

"Veritas Vos Liberabit" (The Truth will set you Free).

VISION:

Transforming the Youth through Holistic Education towards an Enlightened Society.

MISSION:

- To Ensure Inclusion and Access of Quality Education.
- To Provide an Environment of Learning that enhances Dissemination of Knowledge.
- To Nurture Research and Innovation for the betterment of Life and Progress of the Nation.
- To Undertake Collaborative Partnerships for Facilitating Exposure and Sharing.
- To Impart Social and Environmental Sensitivity in Students through Extension and Outreach.
- To Equip Students with Life Skills in Facing Challenges and Responsibilities.
- To Help Students attain Moral, Spiritual and Emotional integrity.

CORE VALUES:

- Faith in God
- Pursuit of Excellence
- Integrity
- Diversity
- Compassion

B.Sc. STATISTICS HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATIONCOURSES)

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at St. Thomas College (Autonomous), Thrissur, a student would:

PO1	Knowledge Acquisition: Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Communication, Collaboration, Inclusiveness, and Leadership: Exhibit effective communication skills, fostering teamwork to demonstrate transformative leadership, exercising inclusivity.
PO3	Professional Skills: Apply professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Digital Intelligence: Utilize varied digital and technological tools proficiently to understand and interact with the digital world, effectively processing complex information.
PO5	Scientific Awareness and Critical Thinking: Solve problems innovatively and mediate effectively by applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Human Values, Professional Ethics, and Societal and Environmental Responsibility: Lead responsibly with a steadfast commitment to human values, ethical conduct, and dedication to the well-being of society and the environment.
PO7	Research, Innovation, and Entrepreneurship: Conduct research and lead entrepreneurial initiatives, forging collaborative partnerships with industry, academia, and communities to develop enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BSc Statistics (Honours) programme at St. Thomas College (Autonomous), Thrissur, a student would:

PSO1	Acquire comprehensive understanding of concepts, principles, and theories of Statistics.
PSO2	Apply fundamental concepts of descriptive and inferential Statistics- exploratory data analysis
PSO3	Master skills in using Statistical Software’s to meet the challenges of Employability, Research and Development.
PSO4	Identify the potential area of applications of Statistical theories.
PSO5	Construct Statistical models for real world problems and obtain solutions
PSO6	Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in Statistical Science

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN STCFYUGP

Sl. No.	**Academic Pathway**	**Major**	**Minor/ Other Disciplines**	**Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3**	**Internship**	**Total Credits**	**Example**
		Each course has4 credits		Each course has 3 credits			
1	Single Major (A)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Statistics + six courses in different disciplines in different combinations
2	Major (A) with Multiple Disciplines (B, C)	68 (17 courses)	12 + 12 (3 + 3 = 6 courses)	39 (13 courses)	2	133	Major: Statistics+ Mathematics and Computer Science
3	Major (A)with Minor (B)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Statistics Minor: Mathematics
Exit with UG Degree / Proceed to Fourth Year with 133 Credits							

B.Sc. STATISTICS (HONOURS) PROGRAMME

COURSE STRUCTURE FOR PATHWAYS 1 – 3

1. Single Major 2. Major with Multiple Disciplines 3. Major with Minor

Semester	Course Code	Course Title	Total Hours	Hours / Week	Credits	Marks		
						Internal	External	Total
1	STA1CJ101/ STA1MN100	Core Course 1 in Major **Univariate Data Analysis**	75	5	4	30	70	100
		Minor Course 1	60/ 75	4/ 5	4	30	70	100
		Minor Course 2	60/ 75	4/ 5	4	30	70	100
		Ability Enhancement Course 1– English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 1 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
2	STA2CJ101/ STA2MN100	Core Course 2 in Major **Bivariate Data Analysis**	75	5	4	30	70	100
		Minor Course 3	60/ 75	4/ 5	4	30	70	100
		Minor Course 4	60/ 75	4/ 5	4	30	70	100
		Ability Enhancement Course 3– English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 2 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	STA3CJ201	Core Course 3 in Major **Mathematical Methods for Statistics I**	60	4	4	30	70	100
	STA3CJ202/ STA3MN200	Core Course 4 in Major **Probability and Random Variables**	75	5	4	30	70	100
		Minor Course 5	60/ 75	4/ 5	4	30	70	100
		Minor Course 6	60/ 75	4/ 5	4	30	70	100
		Multi-Disciplinary Course 3 – Kerala Knowledge System	45	3	3	25	50	75
		Value-Added Course 1 – English	45	3	3	25	50	75
		Total		**23/ 25**	**22**			**550**

4	STA4CJ201	Core Course 5 in Major **Probability Distributions**	75	5	4	30	70	100
	STA4CJ202	Core Course 6 in Major **Bivariate Random Variables and Limit Theorems**	75	5	4	30	70	100
	STA4CJ203	Core Course 7 in Major **Applied Statistics Time Series, Index Numbers & Official Statistics**	75	5	4	30	70	100
		Value-Added Course 2 – English	45	3	3	25	50	75
		Value-Added Course 3 – Additional Language	45	3	3	25	50	75
		Skill Enhancement Course 1 – English	60	4	3	25	50	75
		Total		**25**	**21**			**525**
5	STA5CJ301	Core Course 8 in Major **Estimation**	60	4	4	30	70	100
	STA5CJ302	Core Course 9 in Major **Sampling Methods**	75	5	4	30	70	100
	STA5CJ303	Core Course 10 in Major **Testing of Hypothesis**	75	5	4	30	70	100
		Elective Course 1 in Major	60	4	4	30	70	100
		Elective Course 2 in Major	60	4	4	30	70	100
	STA5FS101	Skill Enhancement Course 2 **Statistical analysis using Python**	45	3	3	25	50	75
		Total		**25**	**23**			**575**
6	STA6CJ301/ STA8MN301	Core Course 11 in Major **Linear Regression Analysis**	75	5	4	30	70	100
	STA6CJ302/ STA8MN302	Core Course 12 in Major **Design and Analysis of Experiments**	75	5	4	30	70	100
	STA6CJ303/ STA8MN303	Core Course 13 in Major **Stochastic Processes**	60	4	4	30	70	100
		Elective Course 3 in Major	60	4	4	30	70	100
		Elective Course 4 in Major	60	4	4	30	70	100
	STA6FS102	Skill Enhancement Course 3 **Basic research methodology**	45	3	3	25	50	75
	STA6CJ349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**

7	STA7CJ401	Core Course 14 in Major **Advanced Analytical Tools**	75	5	4	30	70	100
	STA7CJ402	Core Course 15 in Major **Probability Theory**	75	5	4	30	70	100
	STA7CJ403	Core Course 16 in Major **Distribution Theory**	75	5	4	30	70	100
	STA7CJ404	Core Course 17 in Major **Advanced Sampling Methods & Design of Experiments**	75	5	4	30	70	100
	STA7CJ405	Core Course 18 in Major **Advanced Statistical Inference**	75	5	4	30	70	100
		Total		**25**	**20**			**500**
8	STA8CJ406/ STA8MN406	Core Course 19 in Major **Applied Stochastic Processes and Time Series Analysis**	75	5	4	30	70	100
	STA8CJ407/ STA8MN407	Core Course 20 in Major **Applied Multivariate Techniques**	60	4	4	30	70	100
	STA8CJ408/ STA8MN408	Core Course 21 in Major **Generalized Linear Models**	60	4	4	30	70	100
	OR (instead of Core Courses 19-21 in Major)							
	STA8CJ449	Project (in Honours programme)	360*	13*	12	90	210	300
	STA8CJ499	Research Project (in Honours with Research programme)	360*	13*	12	90	210	300
		Elective Course 5 in Major / Minor Course 7	60	4	4	30	70	100
		Elective Course 6 in Major / Minor Course 8	60	4	4	30	70	100
		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline	60	4	4	30	70	100
	OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme)							
	STA8CJ489	Research Methodology	60	4	4	30	70	100
		Total		**25**	**24**			**600**
Total Credits for Four Years					**177**			**4425**

*The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

CREDIT DISTRIBUTION FOR PATHWAYS 1 – 3

1. Single Major 2. Major with Multiple Disciplines 3. Major with Minor

Semester	**Major Courses**	**Minor Courses**	**General Foundation Courses**	**Internship/ Project**	**Total**
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12* / 12*	24
* Instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

DISTRIBUTION OF MAJOR COURSES IN STATISTICS FOR PATHWAYS 1 – 3

1. Single Major 2. Major with Multiple Disciplines 3. Major with Minor

Semester	Course Code	Course Title	Hours/ Week	Credits
1	STA1CJ101/ STA1MN100	Core Course 1 in Major **Univariate Data Analysis**	5	4
2	STA2CJ101/ STA2MN100	Core Course 2 in Major **Bivariate Data Analysis**	5	4
3	STA3CJ201	Core Course 3 in Major **Mathematical Methods for Statistics I**	4	4
	STA3CJ202/ STA3MN200	Core Course 4 in Major **Probability and Random Variables**	5	4
4	STA4CJ201	Core Course 5 in Major **Probability Distributions**	5	4
	STA4CJ202	Core Course 6 in Major **Bivariate Random Variables and Limit Theorems**	5	4
	STA4CJ203	Core Course 7 in Major **Applied Statistics Time Series, Index Numbers & Official Statistics**	5	4
5	STA5CJ301	Core Course 8 in Major **Estimation**	4	4
	STA5CJ302	Core Course 9 in Major **Sampling Methods**	5	4
	STA5CJ303	Core Course 10 in Major **Testing of Hypothesis**	5	4
		Elective Course 1 in Major	4	4
		Elective Course 2 in Major	4	4
6	STA6CJ304 / STA8MN304	Core Course 11 in Major **Linear Regression Analysis**	5	4
	STA6CJ305 / STA8MN305	Core Course 12 in Major **Design and Analysis of Experiments**	5	4
	STA6CJ306 / STA8MN306	Core Course 13 in Major **Stochastic Processes**	4	4
		Elective Course 3 in Major	4	4
		Elective Course 4 in Major	4	4
	STA6CJ349	Internship in Major	-	2
Total for the Three Years				**70**

7	STA7CJ401	Core Course 14 in Major **Advanced Analytical Tools**	5	4
	STA7CJ402	Core Course 15 in Major **Probability Theory**	5	4
	STA7CJ403	Core Course 16 in Major **Distribution Theory**	5	4
	STA7CJ404	Core Course 17 in Major **Advanced Sampling Methods & Design of Experiments**	5	4
	STA7CJ405	Core Course 18 in Major **Advanced Statistical Inference**	5	4
8	STA8CJ406/ STA8MN406	Core Course 19 in Major **Applied Stochastic Processes and Time Series Analysis**	5	4
	STA8CJ407/ STA8MN407	Core Course 20 in Major **Applied Multivariate Techniques**	4	4
	STA8CJ408/ STA8MN408	Core Course 21 in Major **Generalized Linear Models**	4	4
	OR (instead of Core Courses 19 – 21 in Major)			
	STA8CJ449	Project (in Honours programme)	13	12
	STA8CJ499	Research Project (in Honours with Research programme)	13	12
		Elective Course 5 in Major	4	4
		Elective Course 6 in Major	4	4
		Elective Course 7 in Major	4	4
	OR (instead of Elective course 7 in Major, in Honours with Research programme)			
	STA8CJ489	Research Methodology	4	4
Total for the Four Years				**114**

ELECTIVE COURSES IN STATISTICS

Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
1	STA5EJ301	**Statistical Quality Control**	5	60	4	4	30	70	100
2	STA5EJ302	**Optimization Techniques**	5	60	4	4	30	70	100
3	STA5EJ303	**Biostatistics**	5	60	4	4	30	70	100
4	STA5EJ304	**Econometrics**	5	60	4	4	30	70	100
5	STA5EJ305	**Official Statistics**	5	60	4	4	30	70	100
6	STA5EJ306	**Longitudinal Data Analysis**	5	60	4	4	30	70	100
7	STA6EJ301	**Simulation Techniques**	6	60	4	4	30	70	100
8	STA6EJ302	**Reliability Theory**	6	60	4	4	30	70	100
9	STA6EJ303	**Life Time Data Analysis**	6	60	4	4	30	70	100
10	STA6EJ304	**Demography**	6	60	4	4	30	70	100
11	STA6EJ305	**Actuarial Statistics**	6	60	4	4	30	70	100
12	STA8EJ411	**Statistical Methods for Machine Learning**	8	60	4	4	30	70	100
13	STA8EJ412	**Operations Research**	8	60	4	4	30	70	100
14	STA8EJ413	**Queueing Models**	8	60	4	4	30	70	100
15	STA8EJ414	**Statistical Decision Theory**	8	60	4	4	30	70	100
16	STA8EJ415	**Analysis of Clinical Trials**	8	60	4	4	30	70	100
17	STA8EJ416	**Applied Algorithms and Big Data Techniques**	8	60	4	4	30	70	100
18	STA8EJ417	**Advanced Trends in Statistics**	8	60	4	4	30	70	100

DISTRIBUTION OF MINOR COURSES IN STATISTICS

The minor courses given below should not be offered to the students who have taken statistics as the major discipline. They should be offered to students from other major discipline only.

Sl. No:	Semester	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**Descriptive and Inferential Statistics** (Preferable for Mathematics, Physics, Chemistry and Biochemistry students)								
	1	STA1MN101	**Descriptive Statistics for Data Science**	1	75	5	4	30	70	100
	2	STA2MN101	**Probability theory I**	2	75	5	4	30	70	100
	3	STA3MN201	**Statistical inference using R**	3	75	5	4	30	70	100
2		**Statistical Methodologies in Data Science** (Preferable for Computer Science and Electronics students)								
	1	STA1MN103	**Introductory statistics with R**	1	75	5	4	30	70	100
	2	STA2MN103	**Regression and probability theory**	2	75	5	4	30	70	100
	3	STA3MN203	**Random variables and CART**	3	75	5	4	30	70	100
3		**Behavioural Statistical Techniques** (Preferable for Psychology students)								
	1	STA1MN105	**Descriptive statistics**	1	75	5	4	30	70	100
	2	STA2MN105	**Introduction to probability**	2	75	5	4	30	70	100
	3	STA3MN205	**Inferential Statistics**	3	75	5	4	30	70	100

4		**Bio Statistics** (Preferable for Life Science students)								
	1	STA1MN107	**Basic statistics**	1	75	5	4	30	70	100
	2	STA2MN107	**Statistical inference I**	2	75	5	4	30	70	100
	3	STA3MN207	**Statistical inference II**	3	75	5	4	30	70	100
5		**Statistical Tools for Social Data Analysis** (Preferable for Social Science students)								
	1	STA1MN108	**Statistics for critical thinking I**	1	75	5	4	30	70	100
	2	STA2MN108	**Statistics for critical thinking II**	2	75	5	4	30	70	100
	3	STA3MN208	**Statistics for critical thinking III**	3	75	5	4	30	70	100
6		**Statistical tools for Geospatial Data Analysis** (Preferable for Geography students)								
	1	STA1MN109	**Elementary statistics**	1	75	5	4	30	70	100
	2	STA2MN109	**Theory of Probability**	2	75	5	4	30	70	100
	3	STA3MN209	**Statistical inference**	3	75	5	4	30	70	100
7		**Statistics for Basic Economic Data Analysis** (Preferable for Economics students)								
	1	STA1MN110	**Basic statistics and data visualization**	1	75	5	4	30	70	100
	2	STA2MN110	**Data analysis foundations in statistics**	2	75	5	4	30	70	100
	3	STA3MN210	**Probability theory and sampling techniques**	3	75	5	4	30	70	100
8		**Statistics for Business and Administration** (Preferable for Commerce and Business Administration students)								
	1	STA1MN111	**Fundamentals of data analysis**	1	75	5	4	30	70	100
	2	STA2MN111	**Statistical modeling and sampling techniques**	2	75	5	4	30	70	100
	3	STA3MN211	**Probability theory and statistical distributions**	3	75	5	4	30	70	100

SINGLE MINOR - SIX COURSES IN STATISTICS

Sl. No:	Semester	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
		Single minor - Statistical Inference for Data Science (Preferable for Mathematics, Physics, Chemistry and Biochemistry students)								
1	1	STA1MN101	**Descriptive Statistics for Data Science**	1	75	5	4	30	70	100
		STA1MN102	**Applied statistics using R**	1	75	5	4	30	70	100
	2	STA2MN101	**Probability theory I**	2	75	5	4	30	70	100
		STA2MN102	**Probability theory II**	2	75	5	4	30	70	100
	3	STA3MN201	**Statistical inference using R**	3	75	5	4	30	70	100
		STA3MN202	**Statistical inference for Data Science**	3	75	5	4	30	70	100
		Single minor - Inference using Statistical Softwares (Preferable for Computer Science and Electronics students)								
2	1	STA1MN103	**Introductory statistics with R**	1	75	5	4	30	70	100
		STA1MN104	**Applied statistics**	1	75	5	4	30	70	100
	2	STA2MN103	**Regression and probability theory**	2	75	5	4	30	70	100
		STA2MN104	**Regression using JASP software**	2	75	5	4	30	70	100
	3	STA3MN203	**Random variables and CART**	3	75	5	4	30	70	100
		STA3MN204	**Tests of hypothesis and SVM**	3	75	5	4	30	70	100

		Single minor - Psychological Statistics (Preferable for Psychology students)								
3	1	STA1MN105	**Descriptive statistics**	1	75	5	4	30	70	100
		STA1MN106	**Introductory statistics with JASP**	1	75	5	4	30	70	100
	2	STA2MN105	**Introduction to probability**	2	75	5	4	30	70	100
		STA2MN106	**Correlation and regression**	2	75	5	4	30	70	100
	3	STA3MN205	**Inferential Statistics**	3	75	5	4	30	70	100
		STA3MN206	**Tests of hypothesis with JASP software**	3	75	5	4	30	70	100

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN STATISTICS

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	STA1FM101 STA1FM102	Multi-Disciplinary Course 1 **Quality Control** **Fundamentals of statistics**	45	3	3	25	50	75
2	STA2FM103 STA2FM104	Multi-Disciplinary Course 2 **Managerial Decision Making** **Statistical sampling and probability theory**	45	3	3	25	50	75
5	STA5FS101	Skill Enhancement Course 2 **Statistical analysis using Python**	45	3	3	25	50	75
6	STA6FS102	Skill Enhancement Course 3 **Basic research methodology**	45	3	3	25	50	75

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.

2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.

- In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
- In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.

3. All the 3-credit courses (General Foundational Courses) in Statistics are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practicum	On the other 4 modules		
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
Total		20	10	10	20*
		30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAUM COMPONENT

The evaluation of practicum component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practicum by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practicum examination and viva-voce, and the evaluation of practicum records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practicum courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practicum component shall be as given below:

Sl. No.	Evaluation of Practicum Component of in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practicum/ exercise performed in practicum classes by the students	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practicum records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
				Total Marks	70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm/industry / organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Statistics or allied Disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.

   BSc. Statistics (Honours) Programme, Institute/ Industry visit or study tour is a requirement for the completion of Internship. Visit to minimum one research institute, research laboratory and place of Statistical data analysis importance should be part of the study tour. A brief report of the study tour has to be submitted with photos and analysis.

4. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
5. The log book and the typed report must be submitted at the end of the Internship.
6. The Institution at which the Internship will be carried out should be prior-approved by the Department Council of the College where the student has enrolled for the UG (Honours) Programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through Continuous Assessment mode by a committee internally constituted by the Department Council of the College where the student has enrolled for the UG (Honours) Programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 2 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	10	40%
2		Interim Presentation and Viva-voce	5	
3		Punctuality and Log Book	5	
4	Report of Institute Visit/ Study Tour		5	10%
5	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	6	35%
6		Presentation of the work	5	
7		Viva-voce	6	
8	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		8	15%
	Total Marks		50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution/ any other higher educational institution (HEI)/ research Centre/ training Centre.
- The Project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) isallowed for those belonging to SC/ ST/ OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory ResearchProject of 12-credits instead of three Core Courses in Major in semester 8.
- A faculty member of the Department with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximumfive students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Statistics or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ theoretical/ computational in nature.

4. There should be minimum 300 hrs. of engagement from the student in the Project work in Honours programme as well as in Honours with Research programme.
5. There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme.
6. The various steps in project works are the following:
   - Wide review of a topic.
   - Investigation on a problem in systematic way using appropriate techniques.
   - Systematic recording of the work.
   - Reporting the results with interpretation in a standard documented form. Presenting the results before the examiners.
7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG (Honours) programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.

- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG (Honours) programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the College.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	90	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the College	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	60	20%
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours / Honours with Research)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours / Honours with Research) 12 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Statistics are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General Foundation Course in Statistics	Internal Marks of a General Foundation Course of 3-credits in Statistics	
		4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
Total		20	5
		25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATIONCOURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

5. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree (Honours) or UG Degree (Honours with Research), as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA): The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in

the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

i.e. SGPA (Si) = Σi (Ci x Gi) / Σi (Ci)

where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$\text{SGPA} = \frac{\text{Sum of the credit points of all the courses in a semester}}{\text{Total credits in that semester}}$$

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

CGPA for the three-year programme in STCFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in six semesters}}{\text{Total credits in six semesters (133)}}$$

CGPA for the four-year programme in STCFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in eight semesters}}{\text{Total credits in eight semesters (177)}}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the College shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

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B.Sc. STATISTICS HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

St. Thomas College Four Year Under Graduate Programme
[STCFYUGP]

SEMESTER I

Programme	B. Sc. Statistics				
Course Code	STA1CJ101/STA1MN100				
Course Title	**Univariate Data Analysis**				
Type of Course	**Major**				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	HSE level Mathematics/Statistics courses				
Course Summary Objective	To make the student describe, visualize, distinguish, illustrate single variable data				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Identify and explain various types of data and emphasize the relevance of big data in statistical analysis	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Recognize and interpret measures of central tendency and partition values, and recognize their application scenarios.	Remembering	Factual Knowledge	Quizzes, Assignments
CO3	Calculate various measures of dispersion and interpret their implications.	Applying	Procedural Knowledge	Problem Sets, Practical Exams
CO4	Demonstrate basic R programming skills for statistical calculations, data input, data management, and graphical representation.	Applying	Procedural Knowledge	Lab Assignments, Projects
CO5	Evaluate and compare different measures of central tendency and dispersion to understand data distributions, robustness, and skewness in various data sets.	Analyzing	Analytical Knowledge	Case Studies, Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I		Introduction to Statistics	**10**	**10**
	1	Understanding Types of Data- Categorical, Numerical Data (Discrete and Continuous)		
	2	Time Series Data, Cross-Sectional Data, Nominal and Ordinal Data		
	3	Primary and Secondary data, Design a questionnaire.		
	4	Data Sources in the Digital Age, Challenges and Opportunities in Analysing Modern Data		
II		Measures of Central tendency	**10**	**20**
	5	Arithmetic Mean, Simple and Weighted Mean		
	6	Median, and Mode(Calculation and Interpretation).		
	7	Geometric Mean, Harmonic Mean (Calculation and Interpretation).		
	8	Comparison of Measures of Central Tendency- Scenarios for Applying Mean, Median, and Mode- Robustness of Measures, Partition values.		
III		Measures of Dispersion	**15**	**25**
	9	Absolute and relative measures of dispersion		
	10	Range, Quartile Deviation		
	11	Mean Deviation		
	12	Standard Deviation		
	13	Coefficient of Variation		
	14	Moments- Central and non-Central Moments,		
	15	Measures of Skewness based on Quartiles, Karl Pearson's measure and measure based on Moments		
	16	Kurtosis based on Moments and percentiles		
	17	Barcharts, Histogram and Box plot.		
IV		Introduction to R	**10**	**15**
	18	Statistical software as a programming language		
	19	R as a calculator, R preliminaries		
	20	Getting help, data inputting methods(direct and importing from other spread sheet applications like Excel),		
	21	Data accessing, and indexing, Graphics in R, built in functions,		
	22	Saving, Storing and Retrieving work.		
V		**Practical problems from Univariate data analysis**	**30**	
	1	Practical exercise Hands-on using Software R: Graphical Presentation of Data, Measures of central tendency and dispersion. Case study using primary data in the form of Group Assignments and Discussions. Prepare record of at least 10 questions from Module III and IV using R Package.		

Textbooks :

1. S.C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons
2. Michale J. Crawley, THE R BOOK, John Wiley & Sons, England (2009)

References

1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. Sudha G. Purohitet.al., Statistics Using R, Narosa Publishing House, India(2008)
3. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi.

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3				3			3	3				
CO 2	3				3			3	3				
CO 3			3	3	3				3			3	
CO 4			3	3						3		3	
CO 5					3	3					3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

SEMESTER II

Programme	B. Sc. Statistics				
Course Code	STA2CJ101/STA2MN100				
Course Title	**Bivariate Data Analysis**				
Type of Course	**Major**				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	HSE level Mathematics/Statistics courses				
Course Summary Objective	To equip the students to analyze Bivariate data and Examine agreement / strength of variables				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concept of bivariate data, construct scatter diagrams, and interpret contingency tables for discrete data.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Identify various types of correlation and calculate Karl Pearson's and Spearman's correlation coefficients for grouped and ungrouped data.	Remembering	Factual Knowledge	Quizzes, Assignments
CO3	Apply principles of curve fitting and the least squares method to fit linear, exponential, and power curves for bivariate data.	Applying	Procedural Knowledge	Problem Sets, Practical Exams
CO4	Analyze and interpret regression lines, regression coefficients, and the differences between correlation and regression methods.	Analyzing	Conceptual Knowledge	Case Studies, Lab Assignments
CO5	Explain the properties and applications of multiple and partial correlation coefficients, including their use in analyzing categorical data and associations.	Understanding	Conceptual Knowledge	Exams, Assignments

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I		**Concept of Bivariate Data**	**10**	**15**
	1	Bivariate Data: Definition, Scatter Diagram.		
	2	Contingency tables for discrete data, joint, marginal.		
	3	Curve fitting: Principle of least squares		
	4	fitting of straight line, exponential and power curves using the principle of least squares		
II		**Correlation**	**10**	**20**
	5	Concept and types of Correlation,		
	6	Karl Pearson's Coefficient of Correlation for grouped and ungrouped data and its properties.		
	7	Spearman's Rank Correlation		
	8	Measures using Discordant and Concordant pairs (Kendall's Tau only)		
	9	Point biserial correlation interpretation of correlation coefficient		
III		**Regression**	**15**	**20**
	10	Concept of Regression		
	11	Distinction between Correlation and Regression		
	12	Linear and Non-Linear Regression		
	13	Lines of Regression		
	14	Need of Two lines of Regression		
	15	Regression coefficients		
	16	Properties of Regression Coefficients		
	17	Angle of Regression lines and interpretation		
IV		**Partial and Multiple Correlation**	**10**	**15**
	18	Concepts of Partial and Multiple Correlation Coefficients (three variable cases only).		
	19	Computation of Multiple and Partial Correlation Coefficients		
	20	Properties of Multiple and Partial Correlation Coefficients		
	21	Analysis of Categorical Data: Contingency table,		
	22	Independence & association of attributes: Odds and odds ratio.		
V		**Practical Applications on bivariate data analysis**	**30**	
	1	Practical exercises Hands-on using Software R: Graphical Presentations, Correlation analysis. (Core plot) Prepare record of at least 10 questions.		

Books and References:

1. Christian Heumann, Michael Schomaker, Shalabh., Introduction to Statistics and Data Analysis, Springer Publications,2016
2. S.C.Gupta and V.K.Kapoor., Fundamentals of Applied Statistics, Sultan Chand and Sons

Mapping of COs with PSOs and POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3				2			3	2			
CO2	3		2					3	2			
CO3			3	3					3			2
CO4					3	2					3	
CO5	3				3				2		2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

SEMESTER III

Programme	B. Sc. Statistics				
Course Code	STA3CJ201				
Course Title	**Mathematical Methods for Statistics I**				
Type of Course	**Major**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	HSE level Mathematics course				
Course Summary Objective	Introduce students to the fundamental concepts of Mathematical Analysis.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the order and completeness properties of real numbers, including the Archimedean and Density theorems.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	State and apply foundational theorems related to sequences, such as the Bolzano-Weierstrass and Monotone Convergence Theorems.	Remembering	Factual Knowledge	Multiple-Choice Questions, Homework Assignments
CO3	Apply limit theorems and convergence tests to determine the behavior of sequences and series.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Analyze continuity, uniform continuity, and intermediate value properties of functions, along with their implications for real analysis.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Explain the significance of derivatives, the chain rule, and the Fundamental Theorem of Calculus in relation to the Riemann integral and real analysis.	Understanding	Metacognitive Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I		**Real Line**	**16**	**20**
	1	The Order Properties of Real line (R)		
	2	Absolute Value and the Real Line		
	3	The Completeness Property of Real line		
	4	Archimedean Property		
	5	The Existence of $\sqrt{2}$		
	6	The Density Theorem		
	7	Nested Intervals Property		
	8	Uncountability of Real line. (Concept only)		
II		**Sequences and Series**	**12**	**15**
	9	Sequence, Limit of a Sequence, Monotone sequence, Bounded sequence.		
	10	Limit Theorems, Monotone Convergence Theorem (statement only), Subsequence.		
	11	Bolzano- Weierstrass Theorem		
	12	Cauchy sequence, The Cauchy Criterion, Infinite Series (Introduction only)		
	13	Convergence criteria: Ratio test and root test for convergence of infinite series.		
III		**Functions**	**10**	**20**
	14	Limit of functions		
	15	One-sided Limits.		
	16	Continuous Functions.		
	17	Bolzano's Intermediate Value Theorem.		
	18	Uniform Continuity.		
	19	Monotone and Inverse Functions		
IV		**Differentiation and Integration: Fundamental Concepts**	**10**	**15**
	20	Derivative		
	21	Chain Rule		
	22	The Mean Value Theorem		
	23	Riemann Integral, Riemann Integrable Functions		
	24	Fundamental Theorem of Calculus		
V		**Problems from real number system**	**12**	
	1	Sets and Functions, Finite and Infinite Sets Algebraic Properties of R, Rational and Irrational Numbers,		
	Sections from References:			

Books and References:

1. Bartle R. G. and Sherbert D. R. (2000). Introduction to Real Analysis, 3rd edition, John Sons.
2. Rudin, W. (1976) Principles of Mathematical Analysis, McGraw-Hill, New York. 3.Ro and Fitzpatrick, P. M. (2010). Real Analysis. Prentice Hall.

Mapping of COs with PSOs and POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				2			3	2				
CO2	3							3			2		
CO3			3		2				3			2	
CO4	3				3				3			2	
CO5	3				3		2			3			3

Programme	B. Sc. Statistics				
Course Code	STA3CJ202/STA3MN200				
Course Title	**Probability and Random Variables**				
Type of Course	**Major**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	HSE level Mathematics/Statistics courses				
Course Summary Objective	Familiarize students with set theory, probability, random variables, and moments.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe foundational concepts in set theory, probability, and event structures, including permutations, combinations, and the addition theorem.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Define and apply basic principles of conditional probability, including the multiplication and Bayes theorems.	Remembering	Factual Knowledge	Multiple-Choice Questions, Homework Assignments
CO3	Classify and work with different types of random variables, constructing and interpreting probability mass functions (pmf), probability density functions (pdf), and cumulative distribution functions (cdf).	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Analyze changes in variables through transformations and apply derivative and distribution function methods.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Evaluate expected values, moments, and moment generating functions (MGF) to understand skewness, kurtosis, and other characteristics of random variables.	Evaluating	Metacognitive Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Basics of Set Theory**		**12**	**18**
	1	Definition and properties of sets. Permutations and Combinations		
	2	Random experiment, Sample space, Events,		
	3	Classical definition of probability		
	4	Statistical regularity		
	5	Statistical definition of Probability		
	6	Field, Sigma field, probability space.		
	7	Axiomatic definition of probability and simple properties		
	8	Addition theorem (two and three events)		
II	**Conditional probability**		**10**	**15**
	9	Definition of Conditional probability		
	10	Multiplication theorem		
	11	Independence of events- Pair wise and Mutual		
	12	Bayes theorem and its applications.		
III	**Random variables**		**13**	**20**
	13	Discrete and Continuous Random variables		
	14	Probability mass function (pmf)-properties and examples		
	15	Probability density function (pdf)-properties and examples		
	16	Cumulative distribution function		
	17	Properties of Distribution Function		
	18	Plotting step function/Ladder function		
	19	Change (transformation) of variables.		
	20	Derivative method		
	21	Distribution function method		
IV	**Mathematical Expectation**		**10**	**17**
	22	Expected values of Random Variables		
	23	Raw and Central Moments		
	24	Moment generation function (MGF)		
	25	Properties of MGF		
	26	Characteristic function (definition and use only)		
	27	Moment measures of Skewness and Kurtosis.		
V	**Practical Applications of Probability and Random variables**		**30**	
	1	Solve problems related to probability, including verifying functions as PMF/PDF and evaluating moments, skewness, kurtosis, MGF, and characteristic functions.		

	Books and References 1. S.C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons 2. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd. 3. Christian Heumann, Michael Schomaker and Shalabh (2016): Introduction to Statistics and Data Analysis with Exercises, Solutions and Applications in R., Springer International Publishing Switzerland 4. John E Freund (2014): Mathematical Statistics, Pearson Edn, New Delhi 5. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				2			3	2				
CO2	3							3			2		
CO3			3		2				3			2	
CO4	3				3				3			2	
CO5	3				3		2			3			3

SEMESTER IV

Programme	B. Sc. Statistics				
Course Code	STA4CJ201				
Course Title	**Probability Distributions**				
Type of Course	**Major**				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	HSE level Mathematics/Statistics courses				
Course Summary Objective	To understand random variables, their probability distributions (discrete and continuous cases separately). To analyse their characterization & properties of the distribution. To gain proficiency in transformation of random variables. To analyse their characterization & properties of the real data set.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain standard discrete distributions along with their properties and applications.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Identify properties of discrete distributions including unique attributes like the lack of memory property.	Remembering	Factual Knowledge	Multiple-Choice Questions, Homework Assignments
CO3	Apply definitions, mean, variance, and moment generating functions (MGF) of continuous distributions.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Analyze properties and relationships of the Normal distribution, including derivations of mean, variance, and area properties under the standard normal curve.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Define Lognormal, Pareto, Cauchy, Weibull, and Laplace, assessing their applicability in real-world contexts.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Standard Discrete Distributions I**		**15**	**20**
	1	Degenerate distribution.		
	2	Bernoulli distribution.		
	3	Binomial distribution.		
	4	Poisson distribution.		
	5	Relationship between Binomial and Poisson Distributions		
II	**Standard Discrete Distributions II**		**6**	**14**
	6	Discrete Uniform distribution.		
	7	Multinomial distribution (Definition only).		
	8	Geometric distribution.		
	9	Negative Binomial distribution (definition and basic properties).		
	10	Hyper-geometric distribution (definition and basic properties).		
III	**Standard Continuous distributions I**		**9**	**16**
	9	Rectangular distribution (definition, mean, variance and mgf)		
	10	Exponential distribution.		
	11	Gamma (definition, mean, variance and mgf)		
	12	Beta I kind (definition, mean, variance and mgf)		
	13	Beta II kind (definition olny)		
	14	Relationship between Gamma, Beta I kind and Beta II kind distributions		
IV	**Standard Continuous distributions II**		**15**	**20**
	15	Normal distribution – Definition.		
	16	Standard Normal Distribution		
	17	Derivation of Mean and Variance		
	18	Derivation of Median, Mode, Mean Deviation, Quartile Deviation		
	19	Derivation of MGF and CGF		
	20	Additive property.		
	21	Derivation of Central Moments.		
	22	Area properties of Normal Distribution		
	23	Lognormal, Pareto Distributions (definition only).		
	24	Cauchy, Weibull and Laplace Distributions (definition only).		
V	**Practical problems from standard distributions**		**30**	
	1	Compute density, distribution function, quantile function and random number generation from all standard distribution discussed in the syllabus using R. Pdf/pmf and cdf plots using R.		

Books and References:

1. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and sons 2. V.K. Rohatgi: An introduction to Probability theory and Mathematical Statistics, Wiley Eastern.
2. Mood A.M., Graybill. F.A and Boes D.C.: Introduction to Theory of Statistics McGraw Hill
3. Johnson, N.L., Kemp, A.W., and Kotz, S.. (2005): Univariate Discrete Distributions, 5th edition, Wiley Inter-science, John Wiley & Sons
4. Johnson, N.L., Kotz, S., and Balakrishnan, N. (2002): Continuous Univariate Distributions, Vol. 1, John Wiley
5. Johnson, N.L., Kotz, S., and Balakrishnan, N. (2002): Continuous Univariate Distributions, Vol. 2, John Wiley.
6. Hogg, R. V., Craig, A., and Mckean, J.W. (2019): Introduction to Mathematical Statistics, 8th edition, Pearson 8.
7. John E Freund: Mathematical Statistics (Sixth Edition), Pearson Education (India), New Delhi.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				2			3	2				
CO2	3							3			2		
CO3			3		2				3			2	
CO4	3				3				3			2	
CO5	3				3		2			3			3

Programme	B. Sc. Statistics				
Course Code	STA4CJ202				
Course Title	**Bivariate Random Variables and Limit Theorems**				
Type of Course	**Major**				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	HSE level Mathematics/Statistics courses				
Course Summary Objective	Enable students to understand bivariate distributions, including the bivariate normal distribution, and apply the Law of Large Numbers to compute asymptotic probabilities.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain concepts of bivariate random variables, including joint and marginal probability functions, and analyze independence of random variables.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Identify the properties of joint probability distribution functions and conditional probability functions for bivariate distributions.	Remembering	Factual Knowledge	Multiple-Choice Questions, Homework Assignments
CO3	Apply concepts of bivariate expectation, including the addition and multiplication theorems, covariance, and conditional expectation.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Analyze the properties of the bivariate normal distribution (BVN), including marginal and conditional distributions, and the standard bivariate normal distribution.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Describe the applicability of limit theorems, including the Law of Large Numbers, Central Limit Theorem, and Chebyshev's Inequality, in determining sample sizes and statistical inferences.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications

Detailed Syllabus:

Module	Unit	Content	Hrs(45 +30)	Marks (70)
I	**Bivariate Random Variable**		**10**	**18**
	1	Joint Probability mass function		
	2	Joint Probability density function		
	3	Marginal Probability functions		
	4	Independence of Random Variables. Conditional Probability functions.		
	5	Joint and marginal Probability Distribution function and its properties.		
	6	Jacobian transformation of bivariate random variables.		
	7	Order statistics. (Basic concepts).		
II	**Bivariate Expectation**		**11**	**18**
	8	Mathematical expectation of Bivariate Random Variables.		
	9	Addition theorem of Expectation		
	10	Multiplication theorem of Expectation.		
	11	Covariance, Correlation, Cauchy-Schwartz Inequality		
	12	Conditional Expectation and Conditional Variance		
III	**Bivariate Normal Distribution (BVN)**		**10**	**14**
	13	Probability density function of BVN, properties of BVN		
	14	Marginal Probability density function of BVN		
	15	Conditional Probability density function of BVN		
	16	Standard bivariate normal distribution		
IV	**Limit Theorems**		**14**	**20**
	17	Sequence of random variables and Chebyshev's Inequality		
	18	Convergence in probability.		
	19	Convergence in distribution.		
	20	Weak Law of Large Numbers (iid case)		
	21	Bernoulli's Law of Large Numbers.		
	22	Central Limit Theorem (Lindberg Levy-iid case),		
	23	Applications of CLT		
V	**Practical Applications from bivariate random variables and limit theorems**		**30**	
	1	Solve practical problems involving joint probability laws, marginal and conditional probability functions, conditional expectation and variance, Chebyshev's inequality, Weak Law of Large Numbers (WLLN), and the bivariate normal distribution (BVN).		

Books and References:

1. S. C. Gupta and V. K. Kapoor. Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
2. Samuel Kotz, N. Balakrishnan, Norman L. Johnson. Continuous Multivariate Distributions: Models and Applications. Wiley Series in Probability and Statistics

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				2			3					
CO2	3							3	2				
CO3			3		2				3			2	
CO4	3				3				3			2	
CO5	3				3		2			3			3

Programme	B. Sc. Statistics				
Course Code	STA4CJ203				
Course Title	Applied Statistics Time Series, Index Numbers & Official Statistics				
Type of Course	**Major**				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	HSE level Mathematics/Statistics courses				
Course Summary Objective	Enable students to apply statistical models to time series data and understand the importance of various indices and vital rates.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the components of time series and describe models like additive and multiplicative for analysis.	Understanding	Conceptual Knowledge	Written Exam, Assignments
CO2	Apply methods such as graphical, semi-averages, moving averages, and least squares to measure secular trends.	Applying	Procedural Knowledge	Practical Exams, Projects
CO3	Analyze seasonal variations using methods like simple averages and link relative methods.	Analyzing	Conceptual Knowledge	Assignments, Case Studies
CO4	Explain the significance of time reversal and factor reversal test for various index numbers	Understanding	Conceptual Knowledge	Written Exam, Assignments
CO5	Calculate fertility, mortality, and population growth rates using vital statistics and construct simple life tables.	Applying	Procedural Knowledge	Written Exam, Practical Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Time Series**	**10**	**20**
	1	Time series-definition and Components of time series.		
	2	Additive and Multiplicative models		
	3	Measurement of secular trend - Free Hand/Graphical method		
	4	Method of Semi Averages		
	5	Method of moving averages		
	6	Method of least squares (linear, quadratic and exponential).		
II		**Measurement of Seasonal Variation**	**10**	**15**
	7	Simple average method.		
	8	Ratio to trend Method		
	9	Ratio to moving average		
	10	Method-Link relative method		
III		**Index Numbers**	**14**	**20**
	11	Classification of Index Numbers		
	12	Methods of constructing Index Numbers		
	13	Unweighted Index Numbers, Weighted Index Numbers		
	14	Laspeyre's, Paasche's, Marshal-Edgeworth, Fisher's, Dorbish Bowleys, Kellys index numbers.		
	15	Quantity Index Numbers-Fixed base and chain base Index numbers		
	16	Different tests of a good Index numbers: - Unit test, Time Reversal Test-Factor Reversal Test- Circular test.		
	17	Splicing and base shifting.		
	18	Cost of Living Index Numbers-Consumer Price Index Numbers.		
	19	Family Budget enquiry		
IV		**Vital Statistics**	**11**	**15**
	20	Sources of Vital Statistics (SRS, CRS),		
	21	Fertility rate- CBR, ASFR, TFR, GFR		
	22	Mortality rate- CDR, ASDR, SDR, IMR,		
	23	Population growth- NRR and GRR (definitions only).		
	24	Construction of simple life tables		
V		**Practical Applications from Applied Statistics Time Series, Index Numbers & official statistics**	**30**	
	1	Visit of Government Organizations like NSSO, DES, etc. Case study using secondary data available from government publications.		

Books and References:

1. SC Gupta and VK Kapoor: Fundamentals of Applied Statistics. Sulthan Chand and sons, New Delhi.
2. Parimal Mukhopadhyay: Applied Statistics. Books and Allied (P) Ltd.
3. Box GE and Jenkins G M, Time series Analysis, Holden day

Mapping of COs with PSOs and POs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	1	2	2	3	1	2	3	2	1	2	1	1
CO 2	3	2	2	2	3	1	3	3	3	3	2	2	1
CO 3	2	2	2	3	3	2	2	2	3	2	2	1	1
CO 4	3	1	2	2	2	2	2	3	2	1	2	1	1
CO 5	3	1	3	2	2	3	2	3	2	2	2	1	2

SEMESTER V

Programme	B. Sc. Statistics				
Course Code	STA5CJ301				
Course Title	**Estimation**				
Type of Course	**Major**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	Enable students to understand standard sampling distributions, calculate point estimates and their properties, and construct interval estimates.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe sampling distributions and properties of key distributions such as Chi-square, t, and F-distributions, and explain their interrelationships.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Define and identify characteristics of estimators, including properties of unbiasedness, sufficiency, consistency, and efficiency.	Remembering	Factual Knowledge	Multiple-Choice Questions, Homework Assignments
CO3	Apply estimation methods such as the method of moments and maximum likelihood estimation to determine parameter estimates.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Analyze the conditions for achieving Minimum Variance Unbiased Estimators (MVUE) and apply related theorems like Cramer-Rao inequality, Rao-Blackwell, and Lehmann-Scheffé.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Compute confidence intervals for population parameters such as means, proportions, and variances, and assess their reliability in statistical inference.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications

Detailed Syllabus:

Module	Unit	Content	Hrs(48 +12)	Marks (70)
I		**Sampling Distributions**	**10**	**20**
	1	Definitions of population, sample, parameter, statistic and standard error		
	2	Exact sampling distribution. Chi square distribution (derivations of distributions not required).		
	3	Mean, Variance, MGF		
	4	Mode, Additive property		
	5	Students t distribution (derivation of distribution not required)		
	6	Mean, Variance, Moments		
	7	Snedecor's F distribution (derivation of distribution not required)		
	8	Mean, variance, mode		
	9	Relationship between z, t, F and Chi square distributions.		
	10	Sampling distributions of sample mean and variance.		
II		**Point Estimation**	**10**	**20**
	11	Estimator, Estimate, Properties of good Estimator.		
	12	Unbiasedness, Consistency and Efficiency		
	13	Sufficiency- Factorization theorem, Complete Statistic, Completeness.		
	14	Minimum Variance Unbiased Estimator (MVUE).		
	15	Rao-Blackwell theorem (statement only),		
	16	Lehman Scheffe theorem (statement only),		
	17	Cramer-Rao inequality (statement only), Regularity conditions. MVB Estimators and their applications		
III		**Methods of Estimation**	**20**	**15**
	18	Method of Moments,		
	19	Method of Maximum Likelihood Estimation		
	20	Bayes estimation (Fundamental concepts only)		
IV		**Interval Estimation**	**8**	**15**
	21	Concept of Confidence Interval		
	22	Confidence Intervals for mean of Normal population (Large & small sample cases)		
	23	Confidence Intervals for population Proportion		
	24	Confidence intervals for Variance of Normal population		
	25	Confidence Interval for the difference of means and proportion		
V		**Practical problems from estimation theory.**	**12**	
	1	Solve problems from modules I to IV.		

Books and References:

1. Goon, A.M. Gupta, M.K., and Das Gupta, B. (1980): An outline of statistical theory, Vol.I, 6th revised ed. World Press limited, Calcutta.
2. Gupta, S.C. and Kapoor, V.K. (2014): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
3. Rohatgi, V.K. (1984) An introduction to probability theory and mathematical statistics, Wiley Eastern.

4. Wilks, S.S. (1962): Mathematical statistics - John Wiley & Sons.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				2			3	2				
CO2	3							3	2				
CO3			3		2				3			2	
CO4	3				3				3			2	
CO5	3				3		2			3			3

Programme	B. Sc. Statistics				
Course Code	STA5CJ302				
Course Title	**Sampling Methods**				
Type of Course	**Major**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary Objective	Make students aware of statistical surveys types of sampling methods of sampling and comparing them based on efficiency of estimates				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the basic concepts of census and sample surveys, including sampling types and errors in survey methods.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Define Simple Random Sampling (SRS) methods, distinguish between SRSWR and SRSWOR, and explain their merits and demerits.	Remembering	Factual Knowledge	Quizzes, Short Answer Questions
CO3	Apply estimation techniques to calculate mean, variance, and variance estimations within simple random sampling.	Applying	Procedural Knowledge	Problem Sets, Practical Exercises
CO4	Analyze stratified random sampling to determine optimal allocations for strata, and compare its efficiency over SRS.	Analyzing	Conceptual Knowledge	Case Studies, Lab Assignments
CO5	Evaluate systematic and cluster sampling methods for their applicability, efficiency, and advantages over other sampling methods.	Evaluating	Procedural Knowledge	Exams, Projects

Detailed Syllabus:

Module	Unit	Content	Hrs(45+30)	Marks (70)
I	**Statistical Surveys**		**10**	**15**
	1	Census and Sample Surveys		
	2	Advantages of Sample survey over Census		
	3	Basic concepts of sampling.		
	4	Types of sampling.		
	5	Principal steps in Sample Survey.		
	6	Sampling and non-Sampling errors.		
II	**Simple random sampling**		**12**	**20**
	7	Simple Random Sampling (SRS). Simple Random Sampling with Replacement (SRSWR). Simple Random Sampling without Replacement (SRSWOR)		
	8	Merits and demerits of Simple Random Sampling (SRS).		
	9	Methods of selecting SRS (Lottery method and Random Number method).		
	10	Estimation of Mean		
	11	Variance of estimated mean		
	12	Estimate of estimated variance.		
	13	Unbiased estimate of Population total.		
III	**Stratified random sampling**		**15**	**20**
	14	Need for stratification		
	15	Estimation of mean and variance of estimated mean		
	16	Proportion and optimum allocation.		
	17	Allocation of sample size under Proportional Allocation and variance of estimated mean		
	18	Allocation of sample size under Optimum Allocation and variance of estimated mean		
	19	Comparison of Stratified sampling over SRS		
IV	**Systematic sampling**		**8**	**15**
	20	Systematic sampling – Fundamental concepts (linear and circular)		
	21	Estimation of mean and variance.		
	22	Advantages of systematic sampling over SRS and stratified sampling.		
	23	Comparison of systematic sampling over SRS and stratified sampling.		
	24	Cluster sampling: Clusters with equal sizes		
	25	Estimation of the population mean and total,		
	26	Comparison with simple random sampling		
V	**Sampling Techniques and Estimation**		**30**	
	1	Selection of sample and determination of sample size. Estimation of mean and variance of all sampling methods.		

Books and References:

1. Murthy M.N (1967): Sampling theory and Methods, Statistical Publisher Society, Calcutta.
2. Des Raj (2000): Sample Survey Theory, Narosa publishing house.
3. Sampath S. (2000): Sampling Theory and Methods. Narosa Publishing House.
4. Sukhatme B.V (1984): Sample Survey methods and its Applications, Indian Society of Agricultural Statistics.
5. S.C Gupta and V.K Kapoor: Fundamentals of Applied Statistics. Sultan Chand & Sons.

Mapping of COs with PSOs and POs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3				3			3	2				
CO 2	3							3	2				
CO 3			3		3				3			3	
CO 4	3				3						3	3	
CO 5	3		3				3			3		3	

Programme	B. Sc. Statistics				
Course Code	STA5CJ303(P)				
Course Title	**Testing of Hypothesis**				
Type of Course	**Major**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary Objective	Enable students to understand statistical hypotheses, learn how to formulate correct null and alternative hypotheses, and choose appropriate tests based on the data conditions.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define statistical hypotheses, including null and alternative hypotheses, and distinguish between types of errors in hypothesis testing.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Explain critical region, significance level, test size, and the power of a statistical test.	Remembering	Factual Knowledge	Multiple-Choice Questions, Homework Assignments
CO3	Apply the Neyman-Pearson Lemma to construct uniformly most powerful tests for hypothesis testing scenarios.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Evaluate the use of parametric tests such as large and small sample tests, t-tests, and ANOVA in different testing scenarios.	Evaluating	Metacognitive Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Perform non-parametric tests, including runs test, sign test, Kolmogorov–Smirnov test, Mann-Whitney U test, Kruskal-Wallis test, and chi-square tests.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Statistical Hypothesis**		**9**	**15**
	1	Statistical Hypothesis definition		
	2	Null and Alternative hypothesis		
	3	Simple and Composite hypothesis		
	4	Parametric and Non-parametric test		
	5	Type I and Type-II errors		
	6	Critical Region		
	7	Level of significance & Size of the test		
	8	Power of the test and p- value.		
II	**Tests of hypothesis**		**9**	**15**
	9	Most powerful test		
	10	Uniformly Most Powerful test		
	11	Neyman- Pearson Lemma (statement and proof of sufficiency part only)		
	12	Application of NP Lemma to construct uniformly most powerful test,		
	13	Unbiased test (definition only)		
	14	Likelihood ratio test, properties of likelihood ratio tests (without proof)		
III	**Parametric Tests**		**17**	**20**
	15	Large sample test concerning mean		
	16	Large sample test for equality of means		
	17	Large sample test for proportions		
	18	Large sample test for equality of proportions.		
	19	Small sample tests		
	20	Independent t-test, paired t-test		
	21	Tests for the significance of population variance and equality of variances.		
	22	Concept and applications of one-way ANOVA		
IV	**Non parametric Tests**		**10**	**20**
	23	Introduction and Concept		
	24	Test for randomness based on total number of runs		
	25	Empirical distribution function, One Sample Tests. Kolmogrov – Smirnov test,		
	26	Sign test, Signed rank test (Wilcoxon)		
	27	Mann-Whitney U test. Kruskal-Wallis test (Concept only)		
	28	Chi-square test of goodness of fit		
	29	Chi-square test for independence of attributes		
V	**Practical problems from testing of hypotheses**		**30**	
	1	All statistical tests should be done to students with simple		

		example using R or Python.		

Books and References:

1. Gupta, S.C. and Kapoor, V.K. (2014): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
2. Christian Heumann, Michael Schomaker, Shalabh., Introduction to Statistics and Data Analysis, Springer Publications, 2016
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
4. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons
5. Casella, G. and Berger R.L. (2002). : Statistical Inference, 2nd Edn. Thomson Learning
6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3				2	
CO2	3							3	2				
CO3			3		3				2			3	
CO4	3				3				3		2		
CO5			3		3		2			3			3

SEMSTER VI

Programme	B. Sc. Statistics				
Course Code	STA6CJ301				
Course Title	**Linear Regression Analysis**				
Type of Course	**Major**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary Objective	Objective make students to describe and assess the strength of relationships between variables, to explain them using math model, check adequacy of model				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the basic principles of regression analysis, including model building, scatter diagrams, and regression assumptions.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Construct and interpret simple linear regression models, focusing on least squares and maximum likelihood estimations, hypothesis testing, and coefficient of determination.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO3	Describe the multiple regression model, including assumptions, testing significance of coefficients, and interpreting R^2 and adjusted R^2.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO4	Assess model adequacy using residuals, residual plots, PRESS statistic, and outlier treatment methods.	Analyzing	Metacognitive Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Apply transformations, understand multicollinearity, and use techniques like the Box-Cox transformation and Variance Inflation Factor for regression diagnostics.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Simple Regression**		**10**	**16**
	1	Regression Model building: Scatter Diagram,		
	2	Regressor, Response, Error, uses of Regression.		
	3	Simple Linear Regression model.		
	4	Assumptions, least square and maximum likelihood estimation of the parameters of the model.		
	5	Properties of least square estimators,		
	6	Hypothesis testing on slope and intercept of the model		
	7	Coefficient of Determination		
II	**Multiple Regression**		**10**	**16**
	8	Multiple Regression model, assumptions		
	9	Least square and maximum likelihood estimation of the parameters of the model.		
	10	Testing significance of regression coefficients, test on individual regression coefficient.		
	11	R^2 and adjusted R^2. AIC and BIC (Definition only)		
III	**Model adequacy checking**		**17**	**25**
	12	Model adequacy checking		
	13	Residuals		
	14	Residual plots.		
	15	Methods for scaling residuals- Standardized residuals, studentized residuals (concept only)		
	16	PRESS statistic. R student (Concept only)		
	17	Detection and treatment of outliers		
IV	**Transformations**		**8**	**13**
	18	Transformation and weighting to correct model inadequacy-variance stabilizing transformations		
	19	Transformations to linearize the model.		
	20	Concept of Box-Cox transformation.		
	21	Concepts of multicollinearity, heteroscedasticity and serial correlation.		
	22	Sources of multicollinearity, Variance Inflation Factor		
V	**Practical Applications from simple linear regression**		**30**	
	Practical example of fitting a regression model using statistical software.			

Books and References:

1. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). Introduction to Linear Regression Analysis. Wiley.
2. D. D Joshi (1987). Linear Estimation and Design of Experiments. Wiley
3. Darlington, R. B. (1990). Linear Regression Analysis: Assumptions and Applications. Sage Publications.
4. Seber, G. A. F., & Lee, A. J. (2003). Linear Regression Analysis. Wiley
5. Weisberg, S. (2014). Applied Linear Regression. Wiley.

6. Yan, X., & Chen, M. (2007). Linear Regression Analysis: Theory and Computing. World Scientific.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3		2			
CO2		3	3		3				2	3			
CO3	3				3			3			2	3	
CO4		3		3	3				3		2		
CO5			3		3					3		3	2

Programme	B. Sc. Statistics				
Course Code	STA6CJ302				
Course Title	**Design and Analysis of Experiments**				
Type of Course	**Major**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary Objective	Objective make students aware of designing, planning conducting analysing interpreting-controlled tests, analysing. Differentiating the variation from various sources. Field/Industrial/Organization visit is mandatory.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain key concepts in linear estimation, including estimability, the least squares method, and the Gauss-Markov theorem.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Perform and interpret analysis of variance (ANOVA) in fixed and random effect models, including one-way and two-way ANOVA.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO3	Describe the fundamentals of analysis of covariance (ANCOVA), including model assumptions and applications with single observations per cell.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO4	Discuss the principles and applications of experimental design, including randomization, replication, and local control.	Understanding	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO5	Implement basic experimental designs (CRD, RBD, and LSD), including model adequacy checks and missing plot techniques.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs(45 +30)	Marks (70)
I	**Theory of Linear Estimation**		**10**	**15**
	1	Estimability of linear parametric functions.		
	2	Method of least squares		
	3	Best Linear Unbiased Estimator (BLUE)		
	4	Gauss -Markov theorem		
	5	Linear hypothesis, Estimation of error variance.		
II	**Analysis of variance**		**10**	**15**
	6	Definitions of Fixed effect model and random effect models		
	7	Definition of analysis of Variance,		
	8	Assumptions and Limitations of ANOVA		
	9	One way ANOVA – fixed effect model.		
	10	Two-way ANOVA with a single observation per cell		
III	**Analysis of covariance and Fundamentals of design of experiments**		**17**	**20**
	11	Model of Analysis of covariance		
	12	Analysis of covariance with a single observation per cell		
	13	Experimental Designs		
	14	Basic concepts of experimental Designs		
	15	Principles of design of Experiment		
	16	Randomization		
	17	Replication		
	18	Local Control		
IV	**Basic Designs**		**8**	**20**
	19	Completely randomized design (CRD)		
	20	Randomized Block Design (RBD)		
	21	Latin Square Design (LSD).		
	22	Missing plot technique,		
	23	Comparison of Efficiency, Model Adequacy Checking		
V	**Practical Applications of Design of Experiments**		**30**	
	1	Designing Experiments, Hands on Using R, Practical Interpretation of Results. Practical problems of ANOVA		

Books and References:

1. S.C. Gupta & V.K. Kapoor: Fundamentals of Applied Statistics, Sultan Chand & Sons
2. M.N. Das & N. Giri: Design of Experiments, New Age International
3. Douglas C. Montgomery: Design and Analysis of Experiments, Wiley and Sons

John Lawson: Design, and Analysis of Experiments with R, Chapman and Hall

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Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3		2			
CO2		3	3		3				2	3			
CO3	3				3			3			2	3	
CO4	3			3	3			3					2
CO5		3	3		3					3	2	3	2

Programme	B. Sc. Statistics				
Course Code	STA6CJ303				
Course Title	Stochastic Processes				
Type of Course	Major				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	Equip students with the knowledge of random processes, including stationary and non-stationary processes, discrete and continuous processes, indexed processes, transition probabilities, and Markovian behavior.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define the basic concepts and classifications of stochastic processes, including state space, time space, and types of increments.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Illustrate Markov chains, transition probability matrices, and interpret the Chapman-Kolmogorov equation.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO3	Classify states in Markov chains (recurrent, transient, ergodic) and understand concepts such as periodicity, stationary distributions, and the gambler's ruin problem.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO4	Describe continuous-time Markov chains, including the Chapman-Kolmogorov equation and the Poisson process.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO5	Apply the relationship between the Poisson process and distributions like exponential, binomial, uniform, and geometric in real-world problems.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	**Concept of Stochastic processes**		**10**	**15**
	1	Introduction to Stochastic Processes (SP)		
	2	Definition of state space and time space		
	3	Classification of SP according to state space and time space.		
	4	Process with independent increment		
	5	Process with stationary increment		
II	**Introduction to Markov Chains: Modeling Random Processes**		**10**	**20**
	6	Markov property		
	7	Markov Chain		
	8	Discrete time Markov Chain(MC).		
	9	Transition probability matrix.		
	10	MC as graph.		
	11	Higher transition probabilities,		
	12	Chapman- Kolmogorov Equation.		
	13	One dimensional random walk (concept only)		
III	**Classification of states**		**20**	**20**
	14	First passage probabilities		
	15	PGF.		
	16	Different types of states, classification of states (Recurrent, transient, ergodic)		
	17	Periodicity, mean ergodic theorem (statement only)		
	18	Class property, stationary distribution, limiting distributions,		
	19	Gambler's ruin problem (concept and construction of tpm only).		
IV	**Continuous-time Markov chains**		**8**	**15**
	20	Continuous time MC,		
	21	Chapman-Kolmogorov equation (statement only),		
	22	Poisson Process		
	23	Inter-arrival time.		
	22	Relationship connecting Poisson Process and distributions (exponential, binomial, uniform and geometric)		
V	**Open ended module: Practical problems in stochastic processes**		**12**	
	1	Practical problems relating to Markov Chain, Transition probability matrix		

Books and References:

1. Medhi J. (2014) Stochastic Processes. Third Edition, New Age International
2. Basu A.K. (2003) Introduction to Stochastic Processes, Narosa, New-Delhi.
3. Cinlar E. (2013) Introduction to Stochastic Processes, Dover Publications, New York.
4. Feller W. (1968) Introduction to Probability Theory and its Applications, Vols. I & II,

John Wiley, New York.
5. Karlin S. and Taylor H.M. (1975) A First Course in Stochastic Processes, Second edition, Academic Press, New-York.
6. Ross S.M. (2014) Introduction to Probability models, Eleventh edition, Academic Press

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3		2			
CO2		3	3		3				2	3			
CO3	3				3			3			2	3	
CO4	3			3	3			3					2
CO5		3	3		3					3	2	3	2

VII SEMESTER

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 401				
Course Title	ADVANCED ANALYTICAL TOOLS				
Type of Course	**Major**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practicum per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of Real analysis and Matrix theory.				
Course Summary	The main objective of this course to understand Reimann-Stieltjes integral, Uniform convergence, vector space Eigen values and Eigen vectors.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define the Riemann–Stieltjes Integral, explore its linear properties, integration by parts, and mean-value theorems.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Analyze sequences and series of functions, including pointwise and uniform convergence, and understand continuity and differentiability in multivariable functions.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO3	Apply concepts of vector spaces, including subspaces, linear independence, basis, dimension, and inner product spaces.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Explain matrix theory, including matrix operations, determinants, diagonal reduction, and the use of elementary matrices.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO5	Apply eigenvalue analysis and quadratic form transformations to perform canonical reduction and matrix classification.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Riemann – Stieltjes Integral**	**10**	**15**
	1	Definition, Linear properties- Integration by parts - Change of variable		
	2	Reduction to a Riemann integral		
	3	Step functions as integrators-Reduction to a finite sum		
	4	Monotonically increasing integrators- Riemann conditions- Comparison theorems- Functions of bounded variations (concepts only)		
	5	Necessary & Sufficient conditions for the existence of Riemann Stieltjes integral		
	6	Mean-value theorems		
II		**Sequences and Series of Functions**	**13**	**20**
	7	Point wise convergence of sequence of functions - Examples of sequences of real valued functions		
	8	Definition of Uniform convergence - Uniform convergence and continuity		
	9	Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions		
	10	Uniform convergence and Riemann-Stieltjes Integration - Uniform convergence and differentiation		
	11	Multivariable Functions- Limits and continuity of multivariable functions – Derivatives - directional derivatives		
	12	Total derivative in terms of partial derivatives		
	13	Taylor’s theorem-Inverse and implicit functions.		
III		**Algebra of Vectors**	**10**	**15**
	14	Vector spaces - definition and examples. Linear transformations.		
	15	Subspaces - Linear independence - Basis and dimension- Linear equations		
	16	Vector spaces with an inner product: Properties		
	17	Gram-Schmidt orthogonalization.		
IV		**Algebra of matrices**	**12**	**20**
	18	Theory of matrices and determinants - Matrix Operations- Elementary matrices and diagonal reduction of a matrix- Determinants.		
	19	Generalized inverse of a matrix		
	20	Matrix representations of vector spaces, bases, etc.		
	21	Idempotent matrices. Special products of matrices		
	22	Eigen values and reduction of matrices: Classification and transformations of quadratic forms. Roots of determinant equations. Canonical reduction of matrices.		
V		**Practical problems in algebra of vectors and matrices.**	**30**	
		Hands-on-activities using Python/R. Practical problems relating to algebra of vectors and matrices.		

Text Books

1. Khuri, A.T. (1993). Advanced Calculus with Applications in Statistics. John Wiley &Sons, New York. (Chapter7).
2. Apostol, T.M. (1974). Mathematical Analysis- Second Edition. Narosa Publications, New Delhi.
3. Rao, C.R. (2002). Linear Statistical Inference & Its Applications- Second Edition. John Wiley & Sons, New York.
4. Rao, A.R. & Bhimasankaram, P. (1992). Linear Algebra. Hindustan Book Agency, New Delhi.
5. Lewis, D.W. (1996). Matrix Theory. Allied Publishers, Bangalore.
6. Graybill, F. A. (1983). Matrices with Applications in Statistics. John Wiley & Sons, New York.

References:

7. Widder, D.A. (1996). Advanced Calculus, Second Edition, Prentice Hall, Inc., New Delhi.
8. Malik, S.C. & Arora, S. (2006). Mathematical Analysis- Second Edition. New Age International, New Delhi.
9. Rudin, W. (1976). Principles of Mathematical Analysis- Third Edition. McGraw Hill, New York
10. Biswas, S. (1997). A text book of Linear Algebra. New Age International, New Delhi.
11. Rao, C.R. (2002). Linear Statistical Inference and Its Applications- Second Edition. John Wiley & Sons, New York.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3		2			
CO2		3	3		3				3	2	3		
CO3	3		3		3			3		2		3	
CO4	3			3	3			3			2		3
CO5			3		3					3	3	3	2

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 402				
Course Title	PROBABILITY THEORY				
Type of Course	**Major**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practicum per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic Probability theory, Concept of convergence				
Course Summary	Understanding expectation and various celebrated theorems in classical probability theory.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define and explain the concepts of minimal sigma fields, generated sigma fields, and induced sigma fields, along with their significance in probability theory.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Analyze measure spaces, including finite measures, sigma-finite measures, and signed measures, along with examples to illustrate their applications in probability theory.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO3	Apply the concepts of expectation, moments, and characteristic functions, including their properties and Bochner’s theorem in various contexts.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Explain convergence concepts in probability, including almost sure convergence, convergence in distribution, and convergence in the rth mean, along with their inter-relations.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO5	Utilize theorems such as Lebesgue's Dominated Convergence Theorem, Helly-Bray Theorem, and Lévy's Continuity Theorem in the analysis of convergence and integration.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Sets and classes of events**		**10**	**20**
	1	Definition of field, sigma field, minimal sigma field.		
	2	Random variables, Sigma fields induced by random variables, Vector random variables, limits of sequence of random variables.		
	3	Concept of measure space, finite measure, sigma finite measure, complete measure, counting measure and signed measure (Definition and examples only).		
	4	Probability space, General Probability space.		
	5	Induced probability space.		
II	**Distribution functions of random variables**		**12**	**15**
	6	Decomposition of distribution functions, Distribution function of vector random variables, Correspondence theorem.		
	7	Expectation and moments, Properties of expectations.		
	8	Moments and inequalities		
	9	Characteristic functions, Properties, Inversion theorem		
	10	Characteristic functions and moments, Bochner's theorem (No proof required)		
	11	Independence of classes of events; Independence of random variables		
	12	Kolmogorov 0-1 law; Borel 0-1 law		
III	**Convergence Theorems**		**12**	**20**
	13	Monotone convergence Theorem.		
	14	Fatou's Theorem		
	15	Lebesgue dominated convergence Theorem		
	16	Lebesgue-Stieltjes integral and its reduction to Riemann-Stieltjes integral and Riemann integral.		
	17	Statement and applications of Lebesgue decomposition and Radon-Nikodym theorem.		
IV	**Convergence of random variables**		**11**	**15**
	18	Convergence in probability, Convergence almost surely		
	19	Convergence in distribution, Convergence in rth mean – their inter-relations- examples and counter examples.		
	20	Weak convergence		
	21	Helly-Bray Lemma and Helly – Bray theorem		
	22	Levy continuity theorem.		
V	**Problems in Probability Theory**		**30**	
		Sequences of sets, limit supremum, limit infimum and limit of sets. Monotone sequence of sets. Fields, Sigma fields, Borel sigma field and monotone class. Hands-on-activities using Python/R. Open book problem solving exercises		

Text Books

1. B.R Bhat (1999). Modern Probability Theory, Wiley Eastern
2. Laha & Rohatgi (1979). Probability theory, Wiley New York
3. De Barra, G. (2000). Measure Theory and Integration, New Age International (P) Ltd, New Delhi.

References

1. Ash R. B (2000). Probability and Measure Theory, Second edition. Academic Press.
2. Billingsley P (1985). Probability and Measure, Second edition, John Wiley and Sons, NewYork.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3		2			
CO2		3	3		3				3	2	3		
CO3			3	3	3			3		2		3	3
CO4	3				3			3			3		
CO5			3		3					3	3	3	2

Programme	B. Sc. STATISTICS				
Course Code	STA7 CJ 403				
Course Title	DISTRIBUTION THOERY				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practicum per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of univariate and bivariate distributions. Matrix theory – Eigen Values & Eigen vectors.				
Course Summary	The main objective of this course are to understand the concepts of multivariate probability distributions. Study essential properties of multivariate distributions and apply customized probability distributions in the relevant context.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define and describe the properties of the multivariate normal distribution and its density function, including its applications in statistical analysis.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Analyze linear combinations of the components of a normal random vector and their distributions, applying maximum likelihood estimation techniques for the mean vector and dispersion matrix.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO3	Apply tests for covariance matrices, including the Wishart distribution and tests for equality of covariance matrices, as well as tests for independence among sets of variables.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Explain the concept of quadratic forms, their distributions, and their applications, including the Jacobian of matrix transformations and Cochran's theorem.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO5	Utilize the Hotelling T^2 distribution and Mahalanobis D^2 statistic in hypothesis testing and understand their relationships and optimum properties.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I		**Multivariate Normal Distribution**	**12**	**20**
	1	Definition and properties of multivariate normal density function		
	2	Distribution of a linear combination of the components of a normal random vector.		
	3	Maximum Likelihood estimation of the mean vector and dispersion matrix.		
	4	The distribution of sample mean vector inference concerning the mean vector when the dispersion matrix is known for single and two populations.		
II		**Generalized Variance**	**9**	**15**
	5	Wishart Distribution		
	6	Properties of Wishart distribution		
	7	Test for covariance matrix		
	8	Test for equality of covariance matrices		
	9	Test for independence of sets of variables.		
III		**Quadratic forms and their distributions**	**14**	**15**
	10	Jacobian of matrix transformation of Y=AXB; Y=AXA'; X=TT'		
	11	Independence of a linear form and quadratic form		
	12	Distributions of quadratic form of a multivariate vector		
	13	Cochran's theorem		
	14	Partial and multiple correlation coefficients		
	15	Partial regression coefficients		
IV		**T^2 and D^2 distributions**	**10**	
	16	Hotelling T^2 distribution and its applications		
	17	Generalized T^2 statistic and its distribution		
	18	Uses of T^2 statistic		
	19	Optimum properties of T^2 statistic		
	20	Mahalanobis D^2 statistic and its distribution		
	21	Relation between T^2 and D^2		
	22	Test based on T^2 statistic		
V		**Practical Problems in multivariate normal distribution**	**30**	**20**
		Problems related to partial and multiple correlation coefficients, partial regression coefficients, Hotelling T^2 distribution and Mahalanobis D^2 statistic using R/Python		

Text Book

1. Anderson T W (2010): An Introduction to Multivariate Statistical Analysis, Wiley Eastern Ltd.
2. Johnson, R A and Wichern D W (2003) : Applied Multivariate Statistical Analysis, Prentice-Hall of India Private Ltd., New Delhi.

Reference

1. Jhonson, Kotz and Balakrishna (1991) : Continuous univariate distributions, Vol-1 2nd Ed., John Wiley and Sons
2. Johnson, Kemp and Kotz (1992) : Univariate Discrete distributions, 2nd Ed, John Wiley and Sons
3. Kotz, Balakrishnan, Johnson (2004) : Continuous Multivariate Distributions, Vol 1, 2nd Ed. John Wiley & Sons
4. Mukhopadhyay P (1996) : Mathematical Statistics, New Central Book Agency (P) Ltd. Calcutta.
5. Srivastava, M, C G Khatri (1979) : Introduction to Multivariate Statistics, Elsevier Science Ltd.

Mapping of COs with PSOs and POs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3				3			3	2				
CO 2		3		3					3	2	2		
CO 3			3	3						3		3	
CO 4	3				3			3			3		
CO 5			3							3		3	2

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 404				
Course Title	ADVANCED SAMPLING METHODS AND DESIGN OF EXPERIMENTS				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practicum per week	Total Hours
	4	3	-	2	75
Pre-requisites	Knowledge about sampling procedures and various sampling methods, linear estimation and analysis of variance				
Course Summary	Understand PPS sampling, ratio and regression sampling methods. Identify various factorial design experiments.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the principles of cluster sampling, including methods for estimating mean and variance, relative efficiency, and the determination of optimum cluster size.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Analyze the ratio method of estimation, including the bias, relative bias, and mean square error of ratio estimators, and compare these with regression methods of estimation.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO3	Apply varying probability sampling techniques, including Horvitz-Thompson estimators and the Yates-Grundy forms of variance, and understand multi-stage and multi-phase sampling methods.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Explain the concepts and construction of Balanced Incomplete Block (BIB) designs and analyze data with recovery of inter-block and intra-block information.	Understanding	Conceptual Knowledge	Quizzes, Homework Assignments, Group Discussions
CO5	Utilize factorial designs, including basic definitions, principles, and analysis of 2^n factorial experiments, and apply fractional factorial designs and split plot designs.	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs(45 +30)	Marks (70)
I	**Cluster, Ratio and Regression Sampling**		**12**	**20**
	1	Cluster sampling with equal and unequal clusters		
	2	Estimation of mean and variance, relative efficiency, optimum cluster size, varying probability cluster sampling		
	3	Ratio method of estimation-estimation of ratio, mean and total.		
	4	Bias and relative bias of ratio estimator. Mean square error of ratio estimator. Unbiased ratio type estimator		
	5	Regression methods of estimation		
	6	Comparison of ratio and regression estimators with simple mean per unit method. Ratio and regression method of estimation in stratified population		
II	**Varying probability sampling**		**10**	**15**
	7	PPS sampling with and without replacements		
	8	Des- Raj ordered estimators-Murthy's unordered estimator		
	9	Horvitz-Thompson estimators, Yates and Grundy forms of variance and its estimators		
	10	Zen-Midzuno scheme of sampling, πPS sampling		
	11	Multi stage and multiphase sampling		
III	**Incomplete Block Designs**		**11**	**20**
	12	Incomplete Block Designs. Balanced Incomplete Block designs		
	13	Construction of BIB Designs, Analysis with recovery of inter-block information and intra-block information		
	14	Partially balanced incomplete block designs		
	15	Analysis of partially balanced incomplete block designs with two associate classes		
	16	Youden square design		
	17	Lattice designs		
IV	**Factorial Designs**		**12**	**15**
	18	Basic definitions and principles - Analysis of 2^n factorial experiments		
	19	Total confounding of 2^n designs in 2^n blocks. Partial confounding in 2^n blocks		
	20	3^n factorial designs		
	21	Fractional factorial designs		
	22	Concepts of Split plot design and strip plot design.		
V	**Sampling Methods and Designs: Concepts and Applications**		**30**	

	with R/Python		
	Discuss and solve problems associated with topics in modules I to IV using R/Python		

Text Books

1. Cochran W.G. (1992): Sampling Techniques, Wiley Eastern, New York.
2. D. Singh and F.S. Chowdhary (1986): Theory and Analysis of Sample Survey Design, Wiley Eastern (New Age International), New Delhi.
3. Montgomery D C (2001). Design and Analysis of Experiments, John Wiley.
4. Das M N and Giri N C (1979). Design and Analysis of Experiments, second edition, Wiley.

References

1. P.V.Sukhatme et.al. (1984): Sampling Theory of Surveys with Applications. IOWA State University Press, USA.
2. Des Raj (1976): Sampling Theory. McGraw Hill
3. Mukhopadhyay. P. (1999). Theory and Methods of Survey Sampling. Prentice-Hall India, New- Delhi.
4. Chakrabarti, M.C. (1964). Design of experiments, ISI, Calcutta.
5. Hinkleman and Kempthrone C (1994). Design and Analysis of Experiments Volume I, John Wiley.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3	2				
CO2		3		3					3	2	2		
CO3			3	3						3		3	
CO4	3				3			3			3		
CO5			3							3		3	2

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 405				
Course Title	ADVANCED STATISTICAL INFERENCE				
Type of Course	**Major**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of statistical estimation & testing of hypothesis				
Course Summary	Understand UMVUE and related theorems, UMP tests & SPRT				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concept of sufficient statistics, including the Factorization Theorem, minimal sufficient statistics, and ancillary statistics, and apply these concepts in statistical analysis.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Explain the properties of unbiased estimators, including the Best Linear Unbiased Estimator (BLUE) and Minimum Variance Unbiased Estimator (MVUE), and apply Rao-Blackwell and Lehmann-Scheffé theorems to find MVUEs.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO3	Apply the concepts of consistent estimators and interval estimation methods, including Bayesian and fiducial intervals, to construct and evaluate confidence intervals for different statistical models.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO4	Describe the construction of Uniformly Most Powerful (UMP) tests, including one-sided and two-sided tests, and apply Neyman structure for multi-parameter cases and α-similar tests.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO5	Utilize Sequential Probability Ratio Tests (SPRT) to solve various statistical problems, and analyze its fundamental properties including Operating Characteristic (OC) function and Average Sample Number (ASN).	Applying	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Sufficient statistics and minimum variance unbiased estimators**		**12**	**15**
	1	Sufficient statistics, Factorization theorem for sufficiency, Joint sufficient statistics		
	2	Exponential family, Pitman family, Minimal sufficient statistics (MSS). Criteria to find the MSS, Ancillary statistics, Complete statistics		
	3	Basu's theorem		
	4	Unbiasedness, Best Linear Unbiased estimator (BLUE), Minimum variance unbiased estimator (MVUE)		
	5	Rao-Blackwell theorem		
	6	Lehman-Scheffe theorem		
	7	Necessary and sufficient condition for MVUE, Fisher Information, Cramer Rao inequality and its applications		
II	**CAN estimators and Interval Estimation**		**12**	**20**
	8	Consistent estimator, Invariance property of consistent estimator		
	9	Method of moments-method of percentiles to determine consistent estimators, choosing between Consistent estimators		
	10	CAN estimators		
	11	Definition of Interval estimation, Shortest expected length confidence interval-large sample confidence intervals-unbiased confidence intervals-examples		
	12	Bayesian and Fiducial intervals		
III	**UMP tests**		**11**	**20**
	13	One-sided UMP tests, two- sided UMP tests and UMP unbiased tests		
	14	UMP tests for multi-parameter case: UMP unbiased test		
	15	α-similar tests and α-similar tests with Neyman structure, construction of α-similar tests with Neyman structure		
	16	Principle of invariance in testing of hypotheses, locally most powerful tests		
	17	Likelihood ratio tests		
	18	Bayesian tests		
IV	**Sequential Tests**		**10**	**15**
	19	Some fundamental ideas of sequential sampling – Sequential Probability Ratio Test (SPRT)		

	20	Important properties, termination of SPRT – the fundamental identity of SPRT		
	21	Operating Characteristic (OC) function and Average Sample Number (ASN) of SPRT		
	22	Developing SPRT for different problems		
V	**Problems in Advanced statistical inference**		**30**	
	Discuss and solve problems associated with topics in modules I to IV using R/Python			

Text Books

1. George Casella and Roger L Berger (2002). Statistical inference, Second Edition, Duxbury, Australia.
2. Manojkumar Srivastava and Namita Srivastava (2009). Statistical Inference: Testing of Hypothesis, Eastern Economy Edition, PHI Learning Pvt. Ltd., New Delhi.
3. Rohatgi, V.K(1976). An introduction to Probability Theory and Mathematical Statistics, John Wiley and sons, New York.

References

4. Lehmann, E.L(1983). Theory of point estimation, John Wiley and sons, New York.
5. Rohatgi, V.K (1984). Statistical Inference, John Wiley and sons, New York.
6. Rao, C.R (2002). Linear Statistical Inference and its applications, Second Edition, John Wiley and sons, New York.
7. Lehman, E.L. and Romano, Joseph P.(2005). Testing Statistical Hypotheses. Third Edition, Springer, New- York
8. Kale,B.K . and Muraleedharan K.(2015) Parametric Inference : An Introduction, Alpha Science Intl Ltd.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3				3			3	2				
CO2		3		3					3	2	2		
CO3			3	3						3		3	
CO4	3			3				3			3		
CO5			3							3		3	2

SEMESTER VIII

Programme	B. Sc. STATISTICS				
Course Code	STA 8 CJ 406				
Course Title	APPLIED STOCHASTIC PROCESSES AND TIME SERIES ANALYSIS				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practicum per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of Markov chain & general aspects of time series				
Course Summary	Understand queue, renewal process and Brownian process. Thorough knowledge about auto-correlation and autoregressive moving average.				

Course Outcomes (CO):

COs	Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of Continuous Time Markov Chains, including pure birth and death processes, and the transition probability function.	Understanding	Conceptual Knowledge	Quizzes, Short Answer Questions, Conceptual Discussions
CO2	Apply queueing theory principles to analyze single-server and multi-server queueing systems, including steady-state probabilities and network of queues.	Applying	Procedural Knowledge	Problem Sets, In-Class Exercises, Practical Applications
CO3	Analyze and interpret renewal processes and Brownian motion, including their applications in stochastic modeling.	Analyzing	Conceptual Knowledge	Case Studies, Analytical Problem Solving, Exams
CO4	Formulate and estimate parameters for autoregressive and moving average models, including the Yule-Walker equations and maximum likelihood estimation.	Evaluating	Procedural Knowledge	Quizzes, Homework Assignments, Group Discussions
CO5	Conduct residual analysis and diagnostic checking for ARIMA models to ensure the adequacy of time series forecasting.	Evaluating	Procedural Knowledge	Research Papers, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Continuous time Markov chains and Queueing theory**.		**14**	**20**
	1	Continuous Time Markov Chains		
	2	Pure birth process, Yule furry process, Pure death process, Birth and Death Processes, The transition probability function, Limiting probabilities		
	3	Introduction to queueing theory, Steady state probabilities.		
	4	Exponential Models: A single server Exponential queueing system, A single server Exponential queueing system having finite capacity, Birth and Death queueing models. M/M/1, M/M/C, M/M/C/K, M/M/∞		
	5	Network of queues: Open systems, Closed systems		
	6	Non Markovian queueing models: M/G/1 and G/M/1		
II	**Renewal process and Brownian motion**		**9**	**15**
	7	Renewal processes, renewal function and renewal density, renewal equation, stopping time		
	8	Wald's equation, limit theorems and their applications.		
	9	Brownian motion-Definition, limiting form of random walk, examples.		
	10	White noise, Gaussian process		
	11	Strictly stationary and weakly stationary processes (Definition and examples)		
	12	Branching process (Concept only)		
III	**Time series and stationary process**		**12**	**20**
	13	Time series as a discrete parameter stochastic process		
	14	Auto – Covariance, Auto- Correlation		
	15	Autoregressive, Moving Average, Autoregressive Moving Average and Autoregressive Integrated Moving Average Models		
	16	Choice of AR / MA periods		
	17	Introduction to non-linear time Series: ARCH and GARCH models. SARIMA (Concepts only).		
IV	**Estimation of ARMA models**, ,.		**10**	**15**
	18	Yule – Walker estimation for AR Processes		
	19	Maximum likelihood and least squares estimation for ARMA Processes		
	20	Discussion (without proof) of estimation of mean, Auto-covariance and auto-correlation function under large samples theory		
	21	Residual analysis and diagnostic checking		
	22	Forecasting using ARIMA models		
V	**Practical problems in Applied stochastic process and time series**		**30**	
		Problems, examples and analysis of dataset using software		

Text Books

1. Ross, S.M. (2007). Introduction to Probability Models. IXth Edition, Academic Press.
2. Medhi, J. (1996). Stochastic Processes. Second Editions. New Age International
3. Box G.E.P and Jenkins G.M. (1994). Time Series Analysis, Forecasting and Control.
4. Holden-Day
5. Brockwell P.J. and Davis R.A. (2006). Time Series: Theory and Methods, Springer – Verlag.
6. Abraham B and Ledolter J.C. (1983). Statistical Methods for Forecasting, Wiley
7. Robert H Shumway and Davis S Stoffer(2016). Time series analysis and its applications with R examples. Springer.

References

1. Karlin, S. and Taylor, H.M. (1975). A First Course in Stochastic Processes, Second Edition, Academic Press.
2. Cinlar, E. (1975). Introduction to Stochastic Processes. Prentice Hall. New Jersey.
3. Basu, A.K. (2003). Introduction to Stochastic Processes. Narosa, New-Delhi
4. Anderson T.W (1971). The Statistical Analysis of Time Series, Wiley.
5. Fuller W.A. (1978). Introduction to Statistical Time Series, John Wiley
6. William W. S. Wei (2006). Time Series Analysis: Univariate and Multivariate Methods. Pearson. Addison Wesley.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3							3					
CO2		3							3				
CO3			3							3			
CO4				3	3						3		
CO5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 CJ 407				
Course Title	APPLIED MULTIVARIATE TECHNIQUES				
Type of Course	**Major**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Good knowledge of Multivariate Normal distribution.				
Course Summary	Inculcate deep knowledge on various multivariate techniques. Develop clear idea on when and where to use dependence and interdependence multivariate methods. Bridge the relation between multivariate analysis using software, to strengthen statistical applications in diversified spectrum of life.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts and mathematical foundations of Principal Component Analysis and Factor Analysis, including the estimation of principal components and factor loadings.	Understanding	Conceptual Knowledge	Quizzes, Conceptual Discussions, Short Answer Questions
CO2	Apply canonical correlation analysis to explore relationships between two multivariate sets of variables, including the estimation of canonical variates.	Applying	Procedural Knowledge	Problem Sets, Practical Applications, In-Class Exercises
CO3	Implement classification techniques to classify observations into populations based on known and unknown dispersion matrices, including MANOVA techniques.	Applying	Procedural Knowledge	Case Studies, Analytical Problem Solving, Exams
CO4	Analyze and differentiate between multiple populations using discriminant analysis techniques, including the likelihood ratio method and Fisher's method.	Analyzing	Conceptual Knowledge	Research Projects, Analytical Assignments, Group Discussions
CO5	Evaluate and compare various clustering techniques (hierarchical and non-hierarchical) and their applications in different data scenarios.	Evaluating	Procedural Knowledge	Quizzes, Reflective Essays, Comprehensive Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Principle Component- Factor Analysis-Canonical correlation**		**16**	**20**
	1	Principle component		
	2	Maximum likelihood estimates of the principal components and their variance		
	3	Extraction of Principal Components and their variances		
	4	Factor Analysis – Mathematical model –Estimation of Factor Loading. KMO test (Concept only)		
	5	Canonical correlation – Estimation of canonical correlation and variates		
	6	Structural equation models. (Concept only)		
II	**Classification Problems**		**15**	**20**
	7	Classification problems		
	8	Classification into one of two population (known and unknown dispersion matrix)		
	9	Classification in to one of several populations		
	10	Multivariate analysis of variance (MANOVA) – One way and two-way classification. Permutation test (Concept only).		
	11	Tests independence of sets of variables		
	12	Equality of dispersion matrices and Sphericity test.		
III	**Discriminant Analysis**		**9**	**15**
	13	Discriminant Analysis		
	14	Likelihood ratio method		
	15	Bayes and min-max procedure		
	16	Discrimination between two multivariate normal population with common dispersion		
	17	Sample discriminate function		
	18	Estimation – Fisher's method for discriminating among several populations.		
IV	**Cluster Analysis**		**8**	**15**
	19	Cluster Analysis		
	20	Proximity measures		
	21	Hierarchical clustering techniques: single, complete and average linkage algorithms.		
	22	Non-hierarchical clustering techniques: K means method.		
V	**Practical problems in applied multivariate technique**		**12**	
	Problems regarding Principle Component- Factor Analysis-Canonical correlation, Classification Problems, Discriminant Analysis, Cluster Analysis			

Text Book

1. Anderson T W (2010) : An Introduction to Multivariate Statistical Analysis, Wiley Eastern Ltd.
2. Johnson, R A and Wichern D W (2003): Applied Multivariate Statistical Analysis, Prentice-Hall of India Private Ltd., New Delhi.

Reference

1. Morrison F (2003): Multivariate Statistical Methods, Brooks/Cole, 4th Revised edn., McGraw Hill Book Company
2. Seber G A (2004) : Multivariate Observations, John Wiley.
3. Denis, D J (2021): Applied Univariate, Bivariate and Multivariate Statistics: Understanding Statistics for Social and Natural Scientists, With Application in SPSS and R, John Wiley & Sons.

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3							3					
CO2		3							3				
CO3		3								3			
CO4			3									3	
CO5				3								3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 CJ 408				
Course Title	GENERALIZED LINEAR MODELS				
Type of Course	**Major**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Elementary ideas about linear estimation.				
Course Summary	Understand about generalized linear model s.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the components of a generalized linear model (GLM), including random components, linear predictors, and link functions.	Understanding	Conceptual Knowledge	Quizzes, Conceptual Discussions, Short Answer Questions
CO2	Apply model fitting techniques and inference methods in generalized linear models, including likelihood ratio, Wald, and score methods.	Applying	Procedural Knowledge	Problem Sets, Practical Applications, In-Class Exercises
CO3	Analyze and interpret binary logistic models and other models for nominal and ordinal responses, including baseline-category and cumulative logit models.	Analyzing	Conceptual Knowledge	Research Projects, Analytical Assignments, Group Discussions
CO4	Develop and assess models for count data using Poisson GLMs, Negative Binomial models, and zero-inflated models, including methods for model checking and goodness of fit.	Evaluating	Procedural Knowledge	Quizzes, Reflective Essays, Comprehensive Exams
CO5	Critique and address model misspecification and over dispersion in GLMs, utilizing quasi-likelihood methods and variance inflation techniques.	Evaluating	Procedural Knowledge	Case Studies, Analytical Problem Solving, Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Components of a generalized linear model (GLM)**		**10**	**15**
	1	Random component		
	2	linear predictor, link function		
	3	Quantitative/qualitative explanatory variables and interpreting effects		
	4	Model matrices and model vector spaces		
	5	Identifiability and estimability		
II	**Generalized linear models**		**12**	**20**
	6	Model fitting and inference		
	7	Exponential dispersion family distributions		
	8	Likelihood and asymptotic distributions		
	9	Likelihood-ratio/Wald/Score methods of inference		
	10	Parameters, deviance, model comparison, and model checking		
	11	Goodness of fit		
III	**Binary logistic models, nominal responses**		**10**	**15**
	12	Baseline-category logit models		
	13	Ordinal responses: cumulative logit and probit models		
	14	Probit and complementary log–log models,		
	15	Multinomial response models		
IV	**Models for count data**		**16**	**20**
	16	Poisson GLMs for counts and rates		
	17	Poisson/multinomial models for contingency tables		
	18	Negative Binomial GLMS		
	19	Models for zero-inflated data		
	20	Quasi-likelihood methods		
	21	Variance inflation for over dispersed Poisson and Binomial GLMs		
	22	Beta-Binomial models and Quasi-likelihood alternatives		
	23	Quasi-likelihood and model misspecification		
V	**Problems in generalized linear models**		**12**	
	Model building and validation in practical situations using R software			

Reference

1. Agresti, A. (2015). Foundations of Linear and Generalized Linear Models, Wiley
2. Dobson, A. J. (2002). An Introduction to Generalized Linear Models, 2nd Ed. Chapman & Hall
3. Jiang, J. (2007). Linear and Generalized Linear Mixed Models and their Applications, Springer.
4. Jong, P. and Heller, G. Z. (2008) Generalized Linear Models for Insurance Data, Cambridge University Press.
5. McCullagh, P. and Nelder, J. A. (1989). Generalized Linear Models, Chapman & Hall
6. McCulloch, C. E. and Searle, S. R. (2001). Generalized, Linear and Mixed Models, Wiley
7. Stroup, W. W. (2013). Generalized Linear Mixed Models, Modern Concepts, Methods and Applications, CRC Press

Mapping of COs with PSOs and POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2					3					
CO2	2	3						3				
CO3	2	2	3									
CO4				3	2					3		
CO5					3	2						3

Programme	B. Sc. STATISTICS				
Course Code	STA 8 CJ 489				
Course Title	RESEARCH METHODOLOGY				
Type of Course	**Major**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic knowledge of typesetting & publishing				
Course summary	To understand the concept of Research, presentation & Publication.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the meaning, objectives, and types of research in the context of statistics.	Understanding	Conceptual Knowledge	Written Exam, Assignment
CO2	Conduct a comprehensive literature review and utilize various sources effectively in the design of research work.	Applying	Procedural Knowledge	Project, Presentation
CO3	Identify and articulate the importance of research design, including ethical considerations in statistical research.	Understanding	Conceptual Knowledge	Assignment, Case Study
CO4	Demonstrate proficiency in statistical programming using R for data manipulation, analysis, and model building.	Applying	Procedural Knowledge	Practical Exam, Project
CO5	Implement simulation techniques and Monte Carlo methods for statistical analysis and inference.	Applying	Procedural Knowledge	Practical Exam, Project

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Introduction to Research Methodology in Statistics**		**15**	**20**
	1	Meaning of Research, Objectives of Research		
	2	Types of Research- Descriptive Vs. Analytical, Applied Vs Fundamental, Quantitative Vs Qualitative, Conceptual Vs Empirical		
	3	Concept of Research in Statistics-Importance and Need for Research Ethics		
	4	Selection of Topic for Research-Research schedules, Review of Literature and its Use in Designing a Research Work-		
	5	Mode of Literature Survey-Books and Monographs, Journals, Conference Proceedings, Abstracting and Indexing Journals, E-Journals/Books and CD-ROMS-Reports etc.		
	6	Thesis Writing		
	7	Computer Application in Scientific Research-www-Searching Scientific Articles		
	8	Statistical Data Base		
II	**Scientific Word Processing with LaTeX and MS-Word**		**15**	**20**
	9	Article, Thesis Report and Slides Making		
	10	Power Point Features, Slide Preparation		
	11	Statistical Programming with R: Simple Manipulations Using Numbers and Vectors-Objects & Their Attributes		
	12	Arrays and Matrices-Lists and Data Frames-Grouping, Loops and Conditions		
	13	User Defined Functions		
	14	Probability Distributions and Statistical Models in R		
III	**Simulation**		**10**	**15**
	15	Concepts and Advantages of Simulation		
	16	Event Type Simulation		
	17	Random Variable Generation-U(0,1), Exponential, Gamma and Normal Random Variables		
	18	Monte Carlo Integration		
	19	The MCMC Principle		
	20	Algorithms and its Variants, Bootstrap Methods		
IV	**Computer Oriented Numerical Methods**		**8**	**15**
	21	Algorithms for Solving Algebraic and Transcendental Equations		
	22	Numerical Integration		
	23	Matrix operations		
V	**Practical application of Research methodology**		**12**	
	Solve the problems from Module I to Module IV using software and understand how to check Plagiarism			

References

1. Anderson, J., Durston, B.H., Pooole, M. (1970). Thesis and Assignment Writing. Wiley Eastern. Ltd., New Delhi.4

2. Beveridge, B. (1979). The Art of Scientific Investigation. W.E. Norton & Co., New York.
3. Braun, J., Duncan, W. and Murdock, J. (2008). A First Course in Statistical Programming with R. Cambridge University Press, London.
4. Chambers, J. (2008). Software for Data Analysis: Programming with R. Springer, New York.
5. Dalgaard, P.(2008). Introductory Statistics with R. Springer Science, New York.
6. Kothari, C. (2005). Research Methodology. New Age International. Publishers, New York.
7. Lamport, L. (1999). LATEX: A Document Preparation System. Addison, Wesley, 2nd edition, New York
8. Panneerselvam. (2006). Research Methodology. Prentice-Hall of India. Pvt.,New Delhi.
9. Robert, C.P. and Casella, G. (2004). Monte Carlo Statistical Methods. Springer Science, New York.
10. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., (2002). An Introduction to Research Methodology, RBSA publishers.

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3			2				3					
CO 2		3			2				3				
CO 3			2			3		3					
CO 4				2	3					3			
CO 5	2	3									3		

MAJOR ELECTIVES

SEMESTER V

Programme	B. Sc. Statistics				
Course Code	STA5EJ301				
Course Title	Statistical Quality Control				
Type of Course	**Major Elective**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	To equip students about Various Quality or standards in design Production, Detecting, Controlling and Maintaining Quality and Total Quality Management.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the general theory behind control charts, including their significance in quality control.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Determine and evaluate control limits using statistical methods, including the importance of 3-sigma limits.	Applying	Procedural Knowledge	Projects, Practical Tests
CO3	Construct various types of control charts (mean, range, proportion defective) and analyze their applications in quality control.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Design and implement sampling inspection plans, including single, double, and sequential sampling plans.	Applying	Procedural Knowledge	Projects, Case Studies
CO5	Analyze and construct operating characteristic (OC) curves for different sampling plans using various statistical distributions.	Analyzing	Analytical Knowledge	Exams, Practical Tests

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	**Control Charts theory**		**10**	**15**
	1	General theory of Control Charts.		
	2	Setting Control Limits.		
	3	Importance of 3-sigma limits		
	4	Statistical basis of Control Limits		
	5	Need of two control charts for variables		
	6	Assessing Statistical Control using Charts		
	7	Control Charts for Variables and Attributes		
II	**Control Charts Construction**		**14**	**20**
	8	Mean Chart Theory and Construction		
	9	Dispersion (Range, Standard Deviation Chart) Chart. Theory and Construction		
	10	Proportion defective Chart Theory and Construction		
	11	Number of Defective Chart Theory and Construction		
	12	Number of Defects Chart Theory and Construction.		
III	**Product Control**		**14**	**20**
	13	Sampling Inspection Plans (Acceptance Sampling Plans)		
	14	Single Sampling Plan		
	15	Double Sampling Plan.		
	16	Sequential Sampling Plan		
	17	Incoming and Outgoing Quality		
	18	AQL, RQL, LTPD, AOQ, AOQL		
	19	Errors in Sampling Inspection Plans		
	20	Power function and OC function.		
	21	Producer' and Consumers Risk		
IV	**Characterising Sampling Plans**		**10**	**15**
	22	Constructing OC Curve of Single Sampling Plan using Hyper Geometric distribution		
	23	Constructing OC Curve of Single Sampling Plan using Binomial distribution		
	24	Constructing OC Curve of Single Sampling Plan using Poisson distribution		
	25	Constructing OC Curve of Double Sampling Plan		
	26	ASN, ATI		
V	**Practical problems from Statistical quality control**		**12**	
	1	Discuss and solve practical problem based on the topics in Modules I to IV using R/Python.		

Books and References:

1. Introduction to Statistical Quality Control, 8th Edition Douglas C Montgomery
2. Statistical Quality Control M Mahajan Dhanpat Rai 2nd Edition
3. Fundamentals of Applied Statistics, S C Gupta and V K Kapoor Sultan Chand & Sons

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3			3				3					
CO 2		3			3				3				
CO 3			3			3				3			
CO 4	3	3									3		
CO 5				3	3			3					

Programme	B. Sc. Statistics				
Course Code	STA5EJ302				
Course Title	Optimization Techniques				
Type of Course	**Major Elective**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	To equip students to formulate, solve and implement feasible solutions of complex Industrial, Trade and Commercial problems				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamental concepts of linear programming, including feasible solutions, basic feasible solutions, and graphical methods for solving linear programming problems (LPP).	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Apply the Simplex algorithm and its variations (Artificial Variable Technique, Big M Method, Two Phase Method) to find optimal solutions for linear programming problems.	Applying	Procedural Knowledge	Projects, Practical Tests
CO3	Analyze the concept of duality in linear programming and interpret the economic significance of dual solutions in practical applications.	Analyzing	Analytical Knowledge	Exams, Case Studies
CO4	Solve transportation and assignment problems using methods such as Vogel's Approximation Method, MODI Method, and the Hungarian Method.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO5	Describe decision-making scenarios under conflict using game theory concepts, including pay-off matrices, MinMax/MaxMin criteria, and pure/mixed strategies.	Understanding	Conceptual Knowledge	Assignments, Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I		**Liner Programming Problem**	**14**	**20**
	1	Graphical Solution of LPP.		
	2	Feasible Solution, Basic Feasible Solution of LPP		
	3	Simplex Algorithm without Artificial Variables.		
	4	Artificial Variable technique		
	5	Big M method		
	6	Two Phase method		
II		Application of LPP	**10**	**15**
	7	Duality Primal and Dual LPP		
	8	Economic Interpretation of Dual		
	9	Dual Simplex Method Solution of primal using Dual.		
	10	Transportation and Assignment Problems as special case of LPP.		
	11	Balanced Transportation Problem, Balanced Assignment Problem		
	12	Initial Basic Feasible Solution using NWCR		
	13	Initial Basic Feasible Solution using LCM		
III		**Solving TP & AP**	**12**	**20**
	14	Solution of Transportation Problem using Vogel's Approximation Method		
	15	Optimization using MODI Method		
	16	Hungarian Method of Solving Assignment Problem		
IV		Game Theory		
	17	Decision making under Conflict		
	18	Pay off Matrix.		
	19	MinMax MaxMin Criterions		
	20	Pure and Mixed Strategy		
	21	Value of Game and Saddle Point		
	22	Principle of Dominance, solving 2x2 games.		
	23	Graphical solution of 2xn and nx2 games		
V		**Practical Linear Programming with LINGO & Excel**	**12**	**15**
	1	Linear Programming Problem, Mathematical Formulation, General, Standard form of LPP. Solution of LPP and TPP by LINGO/Excel		

Books and References:

1. Operations Research, Swaroop, Kanti, P. K. Gupta and Man Mohan. 2007. 13th Edition. New Delhi: Sultan Chand and Sons
2. Operations Research, J K Sharma, Laxmi Publications
3. Operations Research V K Kapoor Sulthan Chand and Sons

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3			3				3					
CO 2		3			3				3				
CO 3			3	3						3			
CO 4		3				3					3		
CO 5	3				3			3					

Programme	B. Sc. Statistics				
Course Code	STA5EJ303				
Course Title	Biostatistics				
Type of Course	**Major Elective**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	The student will able to identify the necessity and ethical considerations of clinical trials, as well as the design methodologies for different phases of clinical trials.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain and apply statistical principles in biomedical research.	Applying	Conceptual Knowledge	Assignments, Exams
CO2	Evaluate different study designs and their relevance in medical research.	Evaluating	Analytical Knowledge	Projects, Case Studies
CO3	Analyze survival data using non-parametric methods.	Analyzing	Procedural Knowledge	Lab Exercises, Projects
CO4	Assess the impact of genetic concepts on biostatistical models.	Analyzing	Analytical Knowledge	Exams, Research Papers
CO5	Design clinical trials and evaluate ethical considerations in research.	Creating	Conceptual Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction**		**14**	**20**
	1	Examples of statistical problems in Biomedical Research		
	2	Types of Biological data		
	3	Principles of Biostatistical design of medical studies		
	4	Study designs- observational study, experimental study- comparative experiment, cross over experiment		
	5	Prospective and retrospective study		
	6	Case-control and longitudinal study		
	7	Measuring the occurrence of disease, Measures of morbidity - prevalence and incidence rate, association between prevalence and incidence, uses of prevalence and incidence.		

II	**Survival analysis**		**12**	**20**
	8	Introduction to survival analysis, concepts and definitions		
	9	Survival function		
	10	Probability density function		
	11	Hazard function		
	12	Inter relationships between Survival function, pdf and hazard function.		
	13	Survival distributions- exponential distribution, Weibull distribution and lognormal distribution.		
III	**Types of censoring**		**10**	**15**
	14	Concepts of censoring and truncation		
	15	Type I, Type II and progressive or random censoring with biological examples,		
	16	Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples (for exponential distribution).		
	17	Non-parametric methods for estimating survival function and variance of the estimator- Kaplan –Meier methods.		
IV	**Genetic Principles and Clinical Trial Design in Biostatistics**		**12**	**15**
	18	Basic biological concepts in genetics Mendel's law, Hardy-Weinberg equilibrium		
	19	Random mating, natural selection, mutation, genetic drift,		
	20	Detection and estimation of linkage in heredity		
	21	Planning and design of clinical trials, Phase I, II, and III trials.		
	22	Ethics behind randomized studies involving human subjects; randomized dose-response studies (concept only)		
V	**Practical problems based on survival analysis and clinical trial design**		**12**	
	1	Practical problems based on module I to IV using statistical software.		

Books and References:

Altman, D G. (2006): Practical Statistics for Medical Research, London: Chapman and Hall.

Cox, D.R. and Oakes, D. (1984): Analysis of Survival Data, Chapman and Hall.

Daniel, W.W.(2006): Biostatistics: A Foundation for Analysis in the Health sciences, John Wiley & sons. Inc.

Dunn, G. and Everitt B. (1995): Clinical Biostatistics: An Introduction to Evidence-based Medicine. Edward Arnold.

Friedman, L.M., Furburg, C. and DeMets, D.L. (1998): Fundamentals of Clinical Trials,Springer Verlag.

Gross, A. J. and Clark V.A. (1975): Survival Distribution; Reliability Applications inBiomedical Sciences, John Wiley & Sons.

Lee, Elisa, T. (1992): Statistical Methods for Survival Data Analysis, John Wiley & Sons.

Li, C.C. (1976): First Course of Population Genetics, Boxwood Press.

Fisher, L.D. and Belle, G.V. (1993): Biostatistics: A Methodology for the Health Science, John Wiley & Sons Inc.

Lawless, J.F.(2003): Statistical Methods for Lifetime (Second Edition), John Wiley & Sons.

Rosner B. (2006): Fundamentals of Biostatistics, Edition 6.

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3						3					
CO 2		3	3					3					
CO 3				3	3				3				
CO 4		3	3							3			
CO 5					3	3		3					

Programme	B. Sc. Statistics				
Course Code	STA5EJ304				
Course Title	Econometrics				
Type of Course	**Major Elective**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	After completing the course students should be able to interpret regression results as well as to understand the assumptions underlying the ordinary least squares estimator, and judge in an educated manner whether they hold in a given problem.				

Course Outcomes (CO):

CO	Course Outcome Description	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the purpose and scope of econometrics and its role in model building.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze econometric models using the General Linear Model (GLM) and estimation under linear restrictions.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Identify and test for heteroscedasticity and discuss its consequences in econometric models.	Analyzing	Analytical Knowledge	Lab Exercises, Projects
CO4	Detect and evaluate autocorrelation in econometric data, including tests and consequences.	Analyzing	Analytical Knowledge	Exams, Research Papers
CO5	Conduct multiple regression analysis, identifying multicollinearity and its effects on model estimation.	Evaluating	Analytical Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs(48 +12)	Marks (70)
I		**Introduction**	**10**	**15**
	1	Purpose and scope of Econometrics		
	2	Econometric model		
	3	Model building and role of Econometrics.		
	4	General linear model (GLM).		
	5	Estimation under linear restrictions and properties of estimators		

II	**Heteroscedasticity**		**12**	**20**
	6	Econometric problems		
	7	Heteroscedasticity		
	8	Tests for heteroscedasticity,		
	9	Consequences of heteroscedasticity and solutions		
III	**Autocorrelation**		**12**	**15**
	10	Autocorrelation concept		
	11	Consequences of auto correlated disturbances,		
	12	Detection of Autocorrelation		
	13	Tests of autocorrelation.		
	14	Distributed lag models		
	15	Estimation of parameters		
IV	**Multiple regression**		**14**	**20**
	16	Concept of Multiple regression		
	17	Multiple regression analysis.		
	18	Multi collinearity: Introduction and concepts,		
	19	Detection of multicollinearity,		
	20	Consequences of multicollinearity		
	21	Sources multicollinearity		
	22	Tests and estimation of multicollinearity		
V	**Econometric Analysis and Economic Functions Using Software**		**12**	
	Practical Problems related to OLS/ CLR using softwares. Introduction to various Economic functions (Demand, Supply, Utility, Cost, Revenue etc.)			

Books and References:

1. Gujarathi, D. and Sangeetha, S.(2007). Basic Econometrics, Mc Graw Hill
2. Johnston, J.(2009) Econometric Methods, 4th edition, Mc Graw Hill
3. Judge, G. J, Grifiths, W. E & et al.(1985). Theory and Practice of Econometrics, 2nd edition, John Wiley
4. Introductory Econometrics, a modern approach, 5th edition, Jeffrey M. Wooldridg
5. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Wiley & Sons

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. Statistics				
Course Code	STA5EJ305				
Course Title	Official Statistics				
Type of Course	**Major Elective**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	Equip students with an understanding of the role of Statistics in National Policy Formulation and Government Planning				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Examine the structure and role of statistical systems.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze methods of data collection in official statistics.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Evaluate government statistical publications and their contents.	Evaluating	Analytical Knowledge	Lab Exercises, Projects
CO4	Interpret population growth statistics in socio-economic contexts.	Analyzing	Analytical Knowledge	Exams, Research Papers
CO5	Measure economic indicators and assess inequality in incomes.	Evaluating	Analytical Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction**		**12**	**20**
	1	Introduction to Indian and International Statistical systems.		
	2	Methods of collection of official statistics.		
	3	Role, function and activities of Central and State Statistical organizations.		
	4	Organization of large-scale sample surveys. Role of Ministry of Statistics & Program Implementation (MoSPI),		
	5	Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission.		
	6	Government of India's Principal publications containing data on the topics such as population, industry and finance.		
	7	Scope and Contents of population census of India.		
II	**Socio-Economic and Demographic Statistics**		**12**	**20**
	8	Population growth in developed and developing countries.		

	9	Evaluation of performance of family welfare programmes.		
	10	Projections of labour force and man power.		
	11	Statistics related to Industries, foreign trade, balance of payment		
	12	Statistics related to cost of living, inflation, educational and other social statistics		
III	**Economic Development and National Income Estimation**		**12**	**15**
	13	Economic development		
	14	Growth in per capita income and distributive justice indices of development,		
	15	Human Development Index.		
	16	National income estimation- Product approach		
	17	National income estimation Income approach		
	18	National income estimation Expenditure approach		
IV	**Measuring inequality in incomes**		**12**	**15**
	19	Measuring inequality in incomes: Lorenz curve,		
	20	Gini Coefficient,		
	21	Theil's measure.		
	22	Poverty measurements: Different issues,		
	23	measures of incidence and intensity		
V	**Practical problems from official statistics**		**12**	
	1	Prepare a report based on Wealth – Income distribution disparities		

Books and References: .

1. Guide to Official Statistics (CSO) 1999
2. Statistical System in India (CSO) 1995
3. Principles and Accommodation of National Population Census, UNEDCO.
4. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications
5. Keyfitz, N (1977): Applied Mathematical Demography- Springer Verlag.
6. Sen, A(1977): Poverty and Inequality.
7. Chubey, P.K (1995): Poverty Measurement, New Age International.

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. Statistics				
Course Code	STA5EJ306				
Course Title	Longitudinal Data Analysis				
Type of Course	**Major** Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	Equip students with skills to clean and analyze longitudinal data using multilevel modelling, structural equation modelling, and event history analysis.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explore the principles of longitudinal study design.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze and visualize longitudinal data.	Analyzing	Analytical Knowledge	Projects, Case Studies
CO3	Apply estimation methods in longitudinal data analysis.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Implement generalized linear models for longitudinal data.	Applying	Procedural Knowledge	Exams, Research Papers
CO5	Address issues related to missing data in longitudinal studies.	Evaluating	Analytical Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs(48 +12)	Marks (70)
I	**Introduction**		**12**	**20**
	1	longitudinal studies. Design considerations		
	2	Bias, Efficiency, Sample size calculations.		
	3	Exploring longitudinal data: graphical representation of longitudinal data.		
	4	fitting smooth curves to longitudinal data,		
	5	Exploring correlation structure.		
	6	General linear models for longitudinal data		
II	**Estimation and Analysis**		**12**	**15**
	7	Weighted least-squares estimation,		
	8	Maximum likelihood estimation. Model-fitting: formulation, estimation, inference.		
	9	Analysis of Variance methods: preliminaries,		
	10	Time-by-time ANOVA		
	11	Derived variables, repeated measures		
III	**Generalized Linear Model**		**14**	**20**

	12	Generalized Linear Model for Longitudinal Data:		
	13	Marginal models, for binary, ordinal, and count data:		
	14	Random effects models for binary data:		
	15	Random effects models for ordinal data		
	16	Random effects models for count data		
	17	Transition models		
	18	Likelihood-based models for categorical data		
IV	**Handling Missing Data**		**10**	**15**
	19	Dropouts and missing data		
	20	Classification missing data mechanism; Intermittent missing values and dropouts		
	21	Simple solutions and their limitations		
	22	Last observation carried forward, complete case analysis		
V	**Longitudinal Data Analysis Using Statistical Tools**		**12**	
	1	Formatting and cleaning of longitudinal data (either in long or wide format and their interchangeability), Repeated measures and General linear model fitting, Model fitting for binary ordinal and count data (R, JAMOVI, Mathematica, Stata, SAS)		

Books and References:

1. Diggle, P.J., Heagerty, P., Liang, K.Y and Zeger. S.L (2003). Analysis of Longitudinal Data- Second Edition. Oxford University Press, London.
2. Fitzmaurice,M., Laird,M. and Ware, H. Applied Longitudinal Analysis- Second Edition. John Wiley & Sons, New Jersey.
3. Crowder, M.J. and Hand, D.J. (1990). Analysis of Repeated Measures. Chapman and Hall/CRC Press, London.
4. Hand, D and Crowder, M. (1996). Practical Longitudinal Data Analysis. Chapman and Hall/CRC Press, London.
5. Lindsey, J.K. (1993) Models for Repeated Measurements. Oxford University Press, London.
6. Little, R.J.A, and Rubin, O.B. (2019). Statistical Analysis with Missing Data- Third Edition. John Wiley & Sons, New York.
7. McCullagh, P. and Nelder, J.A (1989). Generalized Linear Models- Second Edition. Chapman and Hall/CRC Press, London.
8. Weiss, R.E. (2005). Modeling Longitudinal Data. Springer, New York

Mapping of COs with PSOs and POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

SEMESTER VI

Programme	B. Sc. Statistics				
Course Code	STA6EJ301				
Course Title	Simulation Techniques				
Type of Course	**Major Elective**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	Equip students with statistical methods to model and analyze various random phenomena				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain random number generation techniques.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Apply simulation methods for statistical distributions.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Utilize Monte Carlo methods for estimation and integration.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Analyze resampling methods for statistical inference.	Analyzing	Analytical Knowledge	Exams, Research Papers
CO5	Implement Markov Chain Monte Carlo methods.	Creating	Procedural Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Random Number Generation and Simulation Techniques**		**10**	**15**
	1	Introduction to random number generation.		
	2	Methods for generating random variables - Inverse transform method		
	3	Composition method, Transformation method		
	4	Acceptance-Rejection method.		
	5	Generating from common statistical distributions Discrete and Continuous. (Rizzo (2019) and Rubinstein (2017		
II	**Advanced Simulation Methods and Statistical Validation**		**12**	**20**
	6	Simulation for the multivariate normal distribution		
	7	Simple estimation based on simulated data		
	8	Monte Carlo integration and variance reduction techniques		
	9	Use of antithetic and control variables		
	10	Statistical validation of the simulated data by goodness of fit		

		tests. (Rizzo (2019), Rubinstein (2017) and Ross (2022))		
III	**Resampling Methods and Statistical Inference Techniques**		**12**	**15**
	11	Introduction to resampling,		
	12	Sampling distribution and other features of a statistic		
	13	Permutation and Randomization tests,		
	14	Theory for Jackknife, Variance estimation-consistency,		
	15	Jack-knife in sample surveys,		
	16	Theory for the bootstrap and its consistency, Distribution and variance estimators (Shao & Tu (2012), Rizzo (2019))		
IV	**Markov Chain Monte Carlo Methods and Density Estimation Techniques**		**14**	**20**
	17	Markov Chain Monte Carlo methods:		
	18	The Metropolis–Hasting's algorithm		
	19	Gibbs sampling.		
	20	EM algorithm.		
	21	Smoothing with kernels		
	22	density estimation (McLachlan & Krishnan (1997), Rubinstein (2017), Robert & Casella (2004) and Rizzo (2019)		
V	**Random Number Generation, Model Fitting, and Resampling for Real-World Data**		**12**	
	Generate random numbers using statistical software for different distributions with its estimation and model fitting. Apply resampling methods for real life data.			

Books and References:

1. Rizzo, M. L. (2019). Statistical Computing with R, second edition. Boca Raton, FL: Chapman & Hall/CRC Press
2. References
3. McLachlan, G.J. and Krishnan, T. (1997): The EM Algorithms and Extensions, Wiley.
4. Robert, C.P. & Casella, G. (2004) Monte Carlo Statistical Methods, 2ndEdn., Springer.
5. Ross, S. M. (2022). Simulation. Academic Press.
6. Rubinstein, R.Y. (2017). Simulation and the Monte Carlo Methods, Wiley.
7. Shao, J., & Tu, D. (2012). The jackknife and bootstrap. Springer Science & Business Media.

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. Statistics				
Course Code	STA6EJ302				
Course Title	Reliability Theory				
Type of Course	**Major Elective**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	Determine the reliability of systems based on defined/determined reliability of the system elements and defined block diagram for the reliability of the observed system.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the components of reliability systems.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze system reliability for independent components.	Analyzing	Analytical Knowledge	Projects, Case Studies
CO3	Compute exact system reliability using advanced methods.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Explore life distributions and their properties.	Analyzing	Analytical Knowledge	Exams, Research Papers
CO5	Examine aging properties of life distributions and coherent structures.	Evaluating	Analytical Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I		**Reliability Systems and Structures**	**10**	**15**
	1	System of components		
	2	Series and parallel structure with examples		
	3	Dual structure function		
	4	Coherent structure		
	5	Preservation of coherent system in terms of paths and cuts		
	6	Representation of bridge structure		
	7	Relative importance of components		
	8	Modules of coherent systems		
II		**System Reliability Analysis**	**10**	**15**
	9	Reliability of a system of independent components		
	10	Some basic properties of system reliability		
	11	Computing exact system reliability		

	12	Inclusion exclusion method		
	13	Reliability importance of components		
III	**Life Distributions and Reliability Functions**		**16**	**20**
	14	Reliability function, hazard function,		
	15	Residual life time, mean residual life function, one-one correspondence of these functions.		
	16	Common life distributions, exponential, weibull, gamma, pareto, lognormal and their characteristics.		
	17	Type –I, Type-II and random censoring schemes.		
	18	Likelihood functions based on these sampling schemes.		
IV	**Aging Properties and Life Distribution Classes**		**12**	**20**
	19	IFR, IFRA, DMRL, NBU, NBUE classes and their duals.		
	20	Exponential distribution and its aging property		
	21	Aging properties of common life distributions		
	22	Classes under formation of coherent structures.		
	Sections from References:			
V	**Applications in Reliability and Life Testing**		**12**	
	1	Estimation and testing based on these schemes for various parametric models.		

Books and References:

Text Books

1. Barlow R.E. and Proschan F.(1985). Statistical Theory of Reliability and Life Testing; Ho Rinehart and Winston.
2. Lawless, J.F. (2003). Statistical Models and Methods for Lifetime (Second Edition), John Wiley Sons Inc., New Jersey.

References

3. Bain L.J. and Engelhardt (1991). Statistical Analysis of Reliability and Life Testing Model Marcel Dekker.
4. Aven, T. and Jensen,U. (1999). Stochastic Models in Reliability, Springer-Verlag, New York, Inc.
5. Nelson, W (1982). Applied Life Data analysis; John Wiley.
6. Zacks, S. (1992). Introduction to Reliability Analysis: Probability Models and Statistics Method New York: Springer-Verlag.

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. Statistics				
Course Code	STA6EJ303				
Course Title	Life Time Data Analysis				
Type of Course	**Major Elective**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	The student has a thorough knowledge of the basic theory of stochastic modelling and statistical analysis of survival data, including graphical techniques. This includes both parametric and non-parametric analysis of censored survival data and data for recurrent events, as well as related regression models				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the basic survival analysis concepts and models.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze censoring and truncation in survival data.	Analyzing	Analytical Knowledge	Projects, Case Studies
CO3	Apply nonparametric methods for estimating survival functions.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Implement semiparametric regression models in survival analysis.	Applying	Procedural Knowledge	Exams, Research Papers
CO5	Evaluate regression models for survival data.	Evaluating	Analytical Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs(48 +12)	Marks (70)
I	**Survival Models and Parametric Methods**		**10**	**15**
	1	Basic Quantities and Models- Survival Function, Hazard function, Mean residual life function		
	2	Common Parametric models for survival data.		
	3	Log location scale models,		
	4	Mixture models.		
II	**Censoring, Truncation, and Likelihood Methods**		**10**	**15**
	5	Right censoring.		
	6	Left censoring		
	7	Interval censoring		
	8	Truncation		
	9	Likelihood construction for censored and truncated data.		

III	**Nonparametric Survival Analysis and Hypothesis Testing**		**18**	**20**
	10	Nonparametric Estimation of Basic Quantities		
	11	Estimators of the Survival Functions for Right-Censored Data		
	12	Estimators of Cumulative Hazard Functions for Right-Censored Data		
	13	Point-wise Confidence Intervals for the Survival Function		
	14	Life Table		
	15	Estimation of Survival in the Cohort Life Table.		
	16	Hypothesis testing- One sample tests		
	17	Tests for two or more samples.		
IV	**Semiparametric and Additive Hazards Models**		**10**	**20**
	18	Semiparametric Proportional Hazards Regression with Fixed Covariates		
	19	Model Building Using the Proportional Hazards Model		
	20	Graphical Checks of the Proportional Hazards Assumption.		
	21	Additive hazards regression models.		
	22	Regression Diagnostics		
V	**Survival Analysis and Parametric Model Fitting with R**		**12**	
	1	Practical exercises on lifetime data using the statistical software R: Fitting the Parametric models for survival data.		

Books and References:

1. Klein J.P. and Moeschberger M.L. (2003) Survival Analysis - Techniques for censored and truncated data, Second Edition, Springer-Verlag , New York.
2. Lawless J.F (2003) Statistical Models and Methods for Lifetime Data, Second Editon, John Wiley & Sons, Relevant Sections of the Chapters 9.
3. Kalbfleisch J.D and Prentice, R.L. (2002) The Statistical Analysis of Failure Time Data, Second Edition, John Wiley & Sons Inc.
4. Deshpande, J .V. and Purohit, S. G. (2006). Lifetime Data: Statistical Models and Methods. World Scientific.

Mapping of COs with PSOs and POs :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. Statistics				
Course Code	STA6EJ304				
Course Title	Demography				
Type of Course	**Major Elective**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	On completion of the course, the students shall be able to Understand basics of Statistical Techniques used in population data analysis.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Indetify the sources of demographic data and methods.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze life tables and their applications.	Analyzing	Analytical Knowledge	Projects, Case Studies
CO3	Measure mortality and fertility rates.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Evaluate migration patterns and their impacts.	Evaluating	Analytical Knowledge	Exams, Research Papers
CO5	Interpret the significance of demographic profiles in India.	Understanding	Conceptual Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	**Demographic Data Sources and Indian Census**		**10**	**15**
	1	Sources of demographic data		
	2	Census and Registration		
	3	Ad-hoc surveys, Hospital records		
	4	Demographic profiles of the Indian Census.		
II	**Life Tables and Population Models**		**10**	**15**
	5	Complete life table and its main features		
	6	Uses of life table. Makehams and Gompertz curves.		
	7	National life tables. UN model life tables.		
	8	Abridged life tables. Stable and stationary populations.		
III	**Mortality and Fertility Measurement**		**16**	**20**
	9	Measurement of Mortality: Crude death rate		

	10	Standardized death rates.		
	11	Age-specific death rates		
	12	Infant Mortality rate		
	13	Death rate by cause		
	14	Measurement of Fertility: Crude birth rate		
	15	General fertility rate		
	16	Age specific birth rate		
	17	Total fertility rate		
IV	**Reproduction Rates and Migration Analysis**		**12**	**20**
	18	Gross reproduction rate, Net reproduction rate		
	19	Internal migration and its measurement, migration models		
	20	Concept of international migration		
	21	Net migration. International and postcensal estimates		
	22	Decennial population census in India		
V	**Practical application using Mortality and fertility measures**		**12**	
	1	Hands-on in R or Excel: Mortality and fertility measures.		

Books and References:

1.S. C. Gupta and V. K. Kapoor. Fundamentals of Applied Statistics. Sultan Chand and Sons. 2.Benjamin B, Health and Vital Statistics, Allen and Unwin.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. Statistics				
Course Code	STA6EJ305				
Course Title	Actuarial Statistics				
Type of Course	**Major Elective**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary Objective	To learn the life tables used in insurance products. To learn the concept of interest, different life insurance products, life annuities, net premiums. To motivate students to prepare for exams required for employment in the actuarial science profession.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the future lifetime distributions and mortality laws.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Construct and analyze life tables.	Analyzing	Analytical Knowledge	Projects, Case Studies
CO3	Apply principles of interest and annuities.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO4	Evaluate life insurance and annuity contracts.	Evaluating	Analytical Knowledge	Exams, Research Papers
CO5	Interpret the implications of actuarial models in practice.	Understanding	Conceptual Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs(48+12)	Marks (70)
I	**Future life time distribution**		**10**	**15**
	1	Future life time random variables,		
	2	Force of mortality, Laws of mortality		
	3	De Moivre's law, Gompertz's Law (Definition only)		
	4	Makeham's Law, Weibull's Law (Definition only)		
	5	Probabilities of survival and death, Curtate Future life time		
II	**Life Tables**		**12**	**20**
	6	Construction of a life table		
	7	Assumptions for fractional ages		
	8	Uniform distribution of deaths		
	9	Balducci assumption,		
	10	Constant force of mortality assumption		

	11	Select and ultimate life tables		
III	**Rates of interest and Annuities**		**16**	**20**
	12	Compound interest and discount factor		
	13	Nominal rate of interest		
	14	Force of interest		
	15	Accumulated value		
	16	Annuities		
	17	Annuities certain- Immediate and due		
	18	Monthly annuity certain		
	19	Continuous annuity certain		
	20	Deferred annuity		
IV	**Life insurance and annuity contracts**		**10**	**15**
	21	Continuous Life insurance contracts		
	22	Term life assurance, Endowment		
	23	Whole life, Continuous Life annuities- whole lie annuity		
	24	n-year temporary life annuity,		
	25	n- year certain and life annuity		
V	**Practical problems from actuarial statistics**		**12**	
	1	Practical problems from actuarial statistics		

1. Books and References:
2. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, Universities Press.
3. Rotar, V.I. (2015). Actuarial Models – The mathematics of Insurance – Second Edition. CRC Press, New York.
4. Promislow, S.D. (2015). Fundamentals of Actuarial Mathematics- Third Edition. John Wiley & Sons, New York.
5. Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A.& Nesbitt, C.J. (1997). Actuarial Mathematics, Society of Actuaries.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

SEMESTER VIII

Programme	B. Sc. STATISTICS				
Course Code	STA8 EJ 411				
Course Title	STATISTICAL METHODS FOR MACHINE LEARNING				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Fundamental knowledge of statistics and proficiency in Python programming				
Course Summary	Understanding Machine learning using Statistics				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamentals of statistical learning.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Apply regression and classification techniques.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Evaluate model performance and accuracy.	Analyzing	Analytical Knowledge	Lab Exercises, Projects
CO4	Implement advanced machine learning algorithms.	Applying	Procedural Knowledge	Exams, Research Papers
CO5	Design and analyze neural network architectures.	Creating	Conceptual Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I		**Statistical Learning**	**10**	
	1	Variable types; Predictors, Features, Responses, Quantitative variables, Categorical variables, Ordered categorical variables		
	2	Approaches to prediction; Least squares and nearest neighbors		
	3	Supervised and Unsupervised learning		
	4	Regression and classification problems		
	5	Assessing model accuracy, Mean square error, The bias-variance trade off		
	6	Comparison of linear regression with K-Nearest Neighbors(KNN) regression		
II		**Classifications**	**14**	
	7	Classification; concepts and its appropriateness in the case of qualitative responses		

	8	Th logistic model		
	9	Linear Discriminant Analysis (LDA) with only one predictor		
	10	Confusion matrix		
	11	Comparison of logistic regression and LDA methods		
	12	Cross validation; Leave-one-out cross validation, K-Fold cross validation		
	13	Decision trees, Regression trees, Classification trees		
	14	Bagging, Random Forests, Boosting.		
III	**Support Vector Machines and Clustering**		**10**	
	15	Maximal margin classifier		
	16	Support vector classifier		
	17	Support vector machines		
	18	K-means clustering		
	19	Hierarchical clustering		
IV	**Neural Networks**		**14**	
	20	Neural Networks; The Basic Architecture of Neural networks		
	21	The perceptron, Activation and Loss functions		
	22	Multi-Layer Neural Networks		
V	**Practical Machine Learning with R and Python**		**12**	
	Apply machine learning to real-life projects using software packages in R or Python. (Based on reference books)			

Text Book

1. Hastie, T., Tibshirani, R. and Friedman, J. (2017). The Elements of Statistical Learning: Data Mining, Inference and Prediction, 2nd edition. Springer, New York
2. James, G., Witten, D., Hastie, T. and Tibshirani, R. (2013). An Introduction to Statistical Learning with Applications in R. Springer, New York.
3. Charu C. Aggarwal (2018). Neural Networks and Deep Learning: A Textbook, Springer

Reference

1. Burger, S. V. (2018). Introduction to Machine Learning with R, O'Reilly Media, Inc.
2. Avila. J, Hauck. T. (2017). Scikit-learn Cookbook: Over 80 Recipes for Machine
3. Learning in Python. Packt Publishing, UK

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA8 EJ 412				
Course Title	OPERATIONS RESEARCH				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic idea about Linear Programming Problems				
Course Summary	Understand advanced models of Linear Programming Problems and Non-Linear Programming Problems.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamentals of linear programming.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Apply simplex methods for optimization.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Analyze integer programming and classical optimization methods.	Analyzing	Analytical Knowledge	Lab Exercises, Projects
CO4	Solve non-linear programming and dynamic programming problems.	Applying	Procedural Knowledge	Exams, Research Papers
CO5	Manage projects using PERT and CPM methodologies.	Evaluating	Conceptual Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Theory of Simplex Method & Revised Simplex Method**		**12**	**20**
	1	Feasible solution, Basic feasible solution, Convex hull, Canonical and Standard form of LP problem		
	2	Reduction of Feasible solution to Basic Feasible solution		
	3	Improving a Basic Feasible Solution-Alternative optimal solutions		
	4	Unbounded Solutions-Unrestricted variables–degeneracy and its Resolution		
	5	Standard forms for Revised Simplex Method- Computational Procedure		
	6	Comparison of Simplex method and Revised Simplex method		
	7	Dual Simplex Method		
II	**Integer Linear Programming & Classical Optimization Methods**		**12**	**20**
	8	Types of Integer Programming Problems-Gomory's all Cutting Plane Method		
	9	Gomory's Mixed Integer Cutting Plane Method		

	10	Branch and Bound Method		
	11	Applications of Zero-One Integer Programming		
	12	Unconstrained Optimization- Optimizing single variable and Multivariable functions		
	13	Constrained Multi Variable Optimization with equality and Inequality constraints		
	14	Lagrange Multipliers Methods		
	15	Kuhn-Tucker Necessary and Sufficient Conditions.		
III	**Non-Linear Programming Methods, Quadratic Programming & Dynamic Programming**		**12**	**15**
	16	The General Non-Linear Programming Problem- Graphical Solution Method		
	17	Quadratic Programming -Kuhn-Tucker Conditions- Wolfe's Modified Simplex Method		
	18	Dynamic Programming -Terminology -Optimal Decision Policy-General Algorithm-		
	19	Dynamic Programming Approach for solving LPP		
IV	**Project Management PERT and CPM, Inventory Control Models**		**12**	**15**
	20	Basic difference between PERT and CPM-Critical Path Analysis		
	21	Estimation of Project completion time- Project Time cost Trade off -Project Crashing -Resource allocation		
	22	Deterministic Inventory Models- EOQ Inventory Models without shortages and with Shortages-		
	23	Probabilistic Models-Newspaper Boy Problem.		
V	**Sequencing, Maintenance Models, and Simulation Techniques.**		**12**	
	Sequencing Problem, Replacement and Maintenance Models Simulation Techniques			

Reference

1. Mital. K. V. and Mohan. C. (1996). Optimization Methods in Operations Research and Systems Analysis Third Edition, New Age International (Pvt) Ltd., New Delhi.
2. Taha. H.A. (2007). Operations Research – An Introduction-Eighth Edn. Pearson Printice Hall, new Jersey.
2. Sharma J.K. (2003). Operations Research-Theory and Applications, Macmillan
3. Indian Ltd., New Delhi
4. Man Mohan, Kanti Swarup and Gupta (1999). Operations Research, Sulthan Chand & Sons, New Delhi.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3							3					
CO2		3							3				
CO3			3							3			
CO4				3							3		
CO5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 EJ 413				
Course Title	QUEUEING MODELS				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Basic knowledge of Markov Chain & Stochastic process				
Course Summary	Detail analysis of Queueing Models				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamentals of queueing theory.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Apply Markovian queueing models for performance analysis.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Analyze transient behavior in queueing systems.	Analyzing	Analytical Knowledge	Lab Exercises, Projects
CO4	Evaluate and design queueing networks.	Evaluating	Conceptual Knowledge	Exams, Research Papers
CO5	Develop general queueing models for complex systems.	Creating	Procedural Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Queueing Theory**		**12**	**20**
	1	Introduction to queueing theory, Cost Equations, Steady-State Probabilities		
	2	Characteristics of queueing processes, Measures of effectiveness		
	3	Markovian queueing models		
	4	steady state solutions of the M/M/I model, waiting time distributions		
	5	Little's formula, queues with unlimited service, finite source queues		
II	**Transient Behavior**		**12**	**15**
	6	Transient behavior of M/M/1 queues		
	7	Transient behavior of M/M/∞		
	8	Busy period analysis for M/M/1 and M/M/c models		
	9	Advanced Markovian models		
	10	Bulk input $M^{[X]}$ /M/1 model, Bulk service M/$M^{[Y]}$ /1 model		
	11	Erlangian models, M/Ek/1 and Ek/M/1		
	12	A brief discussion of priority queues		

III	**Queueing Networks**		**12**	**20**
	13	Queueing networks-series queues		
	14	Open Jackson networks		
	15	Closed Jackson network		
	16	Cyclic queues		
	17	Extension of Jackson networks		
	18	Non Jackson networks		
IV	**General Queueing Models**		**12**	**15**
	19	Models with general arrival pattern, The M/G/1 queueing model		
	20	The Pollaczek-khintchine formula, Departure point steady state systems size probabilities, ergodic theory		
	21	Special cases M/Ek/1 and M/D/1, waiting times, busy period analysis, general input and exponential service models,		
	22	Arrival point steady state system size probabilities		
V	**Practical problems from queuing models**		**12**	
	Problems regarding Module I to Module IV			

Reference

1. Gross, D. and Harris, C.M.(1985). Fundamentals of Queuing Theory, 2nd Edition, John Wiley and Sons, new York.
2. Kleinrock L (1975). Queuing Systems, Vol. I &Vol 2, John Wiley and Sons, New York.
3. Ross, S.M. (2007). Introduction to Probability Models. 9th Edition, Academic Press, New York.
4. Bose, S.K. (2002). An Introduction to Queuing Systems, Kluwer Academic/Plenum Publishers, New York.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 EJ 414				
Course Title	STATISTICAL DECISION THEORY				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Statistical testing hypothesis, Priori & Posterior probability				
Course Summary	To understand different decision rule using statistics and Bayesian analysis.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the foundations of statistical decision theory.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Apply prior information in decision-making.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Analyze posterior distributions for Bayesian inference.	Analyzing	Analytical Knowledge	Lab Exercises, Projects
CO4	Evaluate Bayesian decision rules for robustness.	Evaluating	Conceptual Knowledge	Exams, Research Papers
CO5	Describe game theory in the context of statistical decision-making.	Understanding	Conceptual Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Statistical decision Problem**		**12**	**15**
	1	Decision rule		
	2	Loss-randomized decision rule		
	3	Decision Principle - sufficient statistic and convexity		
	4	Utility and		
	5	Loss-loss functions		
	6	Standard loss functions vector valued loss functions		
II	**Prior information**		**12**	**20**
	7	subjective determination of prior density		
	8	Non-informative priors		
	9	Maximum entropy priors he marginal distribution to determine the prior		

	10	the ML-II approach to prior selection		
	11	Conjugate priors		
III	**The posterior distribution**		**12**	**20**
	12	Bayesian inference		
	13	Bayesian decision theory		
	14	Empirical Bayes analysis		
	15	Hierarchical Bayes analysis		
	16	Bayesian robustness Admissibility of Bayes rules		
IV	**Game theory**		**12**	**15**
	17	Basic concepts		
	18	General techniques for solving games		
	19	Games with finite state of nature		
	20	the supporting and separating hyper plane theorems		
	21	The minimax theorem		
	22	Statistical games		
V	**Applications of Statistical Decision Theory**		**12**	
	Problems regarding Module I to Module IV			

Text Book

1. Berger, O.J. (1985). Statistical Decision Theory and Bayesian Analysis – Second Edition. Springer, New York.

Reference

1. Ferguson, T.S. (1967). Mathematical Statistics-A Decision Theoretic Approach. Academic Press, New York.
2. Lehman, E.L. (1998). Theory of Point Estimation-Second Edition. John Wiley, New York.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 EJ 415				
Course Title	ANALYSIS OF CLINICAL TRIALS				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Different sampling techniques and design of experiments				
Course Summary	To understand different methods to analyze medical data.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamentals of clinical trials.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Design effective clinical trial protocols.	Applying	Procedural Knowledge	Projects, Case Studies
CO3	Analyze data from clinical trials.	Analyzing	Analytical Knowledge	Lab Exercises, Projects
CO4	Evaluate the implications of surrogate endpoints in trials.	Evaluating	Conceptual Knowledge	Exams, Research Papers
CO5	Conduct meta-analysis of clinical trial data.	Creating	Procedural Knowledge	Practical Tests, Reports

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Basics of Clinical Trials**		**12**	**20**
	1	Introduction to clinical trials		
	2	The need and ethics of clinical trials, bias and random error in clinical studies		
	3	Protocols, conduct of clinical trials, over view of Phase I-IV trials		
	4	Data management-data definitions, standard operating Procedure		
	5	Informed consent form, case report forms, database design		
	6	Data collection systems for good clinical practice		
II	**Design of Clinical Trials**		**12**	**15**
	7	Design of clinical trials		
	8	Different phases, Comparative and controlled trials, Random allocation, Randomization, response adaptive methods and restricted randomization		
	9	Methods of Blinding, Parallel group designs, Crossover designs, Symmetric designs, Adaptive designs, Group sequential designs		

	10	Zelen's designs, design of bioequivalence trials		
	11	Outcome measures		
III	**Sample Size Determination and Testing**		**12**	**20**
	12	Sample size determination in one and two sample cases		
	13	Comparative trials, activity studies, testing and other purposes		
	14	Unequal sample sizes and case of anova		
	15	Surrogate endpoints-selection and design of trials with surrogate endpoints		
	16	Analysis of surrogate end point data		
	17	Reporting and Analysis		
	18	Interpretation of result, multi-center trials		
IV	**Meta-Analysis**		**12**	**15**
	19	Meta-analysis in clinical trials-concept and goals, fixed and random effect approaches		
	20	Bioassay: Direct and indirect assays		
	21	Quantal and quantitative assays		
	22	Parallel line and slope ratio assays, Design of bioassays		
V	**Practical Analysis of Clinical Trials**		**12**	
	Problems regarding Module I to Module IV			

Text Book

1. Friedman, L. M., Furburg, C. D. Demets, L. (1998). Fundamentals of Clinical Trials, Springer Verlag.
2. Jennison and Turnbull, B.W. (1999). Group Sequential Methods with Applications to Clinical Trials, CRC Press.
3. Kulinskaya, E, Morgeathaler, S and Staudte R G (2008). Meta-analysis, Wiley.

Reference

1. Fleiss, J. L. (1989). The Design and Analysis of Clinical Experiments, Wiley.
2. Marubeni, E. and M. G. Valsecchi (1994). Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley and Sons.
3. Piantadosi S. (1997). Clinical Trials: A Methodological Perspective. Wiley.
4. W Rosenberger, J MLachin (2002). Randomization in Clinical Trials Theory and Practice, Wiley

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 EJ 416				
Course Title	APPLIED ALGORITHMS AND BIG DATA TECHNIQUES				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Statistical Machine Learning				
Course Summary	To understand how handle big data using EM algorithm, supervisory and un-supervisory learning				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Apply the EM Algorithm to mixture models.	Applying	Procedural Knowledge	Assignments, Exams
CO2	Implement Support Vector Machines for classification.	Applying	Procedural Knowledge	Projects, Lab Exercises
CO3	Analyze and interpret Big Data characteristics.	Analyzing	Analytical Knowledge	Case Studies, Exams
CO4	Apply Multi-Dimensional Scaling techniques.	Applying	Procedural Knowledge	Lab Exercises, Projects
CO5	Synthesize findings from Big Data analytics.	Creating	Conceptual Knowledge	Research Reports, Presentations

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**EM Algorithm**		**12**	**20**
	1	Two-Component Mixture Model		
	2	Gaussian Models		
	3	The EM Algorithm in General		
	4	EM as a Maximization–Maximization Procedure		
II	Support Vector Machines		**10**	**15**
	5	Maximal Margin Classifier		
	6	Support Vector Classifiers		
	7	Support Vector Machines		
	8	SVMs with More than Two Class- One- Versus-One Classification and One-Versus-All Classification		
III	**Big Data**		**10**	**15**
	9	Definition, Characteristics		

	10	Data Analytics		
	11	General Categories of Data Analytics		
	12	Structured, Unstructured and Semi Structured Data		
	13	Meta data		
	14	Big Data Analytics Life Cycle.		
IV	**Multi-Dimensional Scaling**		**16**	**20**
	15	Definition, Perceptual Map		
	16	Decision Frame- work for Perceptual Mapping,		
	17	Non-metric versus Metric methods		
	18	Similarities Data,		
	19	Preferences Data		
	20	Aggregate and Disaggregate Analysis		
	21	De-compositional and Compositional approaches		
	22	Interpreting the MDS results		
V	**Practical Problems from Big data analytics**		**12**	
	Practical Problems from Module I to Module IV using software's			

Text Books/ References

1. Hastie, T., Tibshirani, R. and Friedman, J. (2017).The Elements of Statistical Learning, Data Mining, Inference and Prediction, 2nd edition. Springer, New York.
2. James, G., Witten, D., Hastie, T. and Tibshirani,R.(2013). An Introduction to Statistical Learning with Applications in R. Springer, New York.
3. Erl, T. and Khattak, W. (2016). Big Data Fundamentals Concepts, Drivers & Techniques.
4. Prentice Hall.
5. Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E.(2009). Multivariate Data Analysis, 7thedition. Prentice Hall, New York.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Programme	B. Sc. STATISTICS				
Course Code	STA 8 EJ 417				
Course Title	ADVANCED TRENDS IN STATISTICS				
Type of Course	**Major Elective**				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Thorough knowledge of probability distributions				
Course Summary	To understand Johnson's system of distributions, Burr family of distributions, Infinite divisibility, U-Statistics & Stochastic ordering.				

Course Outcomes (CO):

CO	Course Outcomes (COs)	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe various systems of distributions.	Understanding	Conceptual Knowledge	Assignments, Exams
CO2	Analyze the properties of U-statistics.	Analyzing	Analytical Knowledge	Case Studies, Exams
CO3	Evaluate univariate stochastic orders.	Evaluating	Analytical Knowledge	Projects, Presentations
CO4	Apply univariate variability orders in statistical analysis.	Applying	Procedural Knowledge	Lab Exercises, Exams
CO5	Synthesize knowledge of infinite divisibility in probability distributions.	Creating	Conceptual Knowledge	Research Reports, Projects

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3							3					
CO 2		3							3				
CO 3			3							3			
CO 4				3							3		
CO 5					3							3	

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Distribution Theory**		**12**	**15**
	1	Systems of distributions		
	2	Johnson's S_B system		
	3	Johnson's S_u system		
	4	Burr distributions		
	5	Infinite divisibility of probability distributions- (i) the non-negative integers		
	6	Infinitely divisible distribution on (ii) the non-negative real's		
II	**U-Statistics**		**12**	**20**
	7	Basic description of U-statistics		
	8	Variance and other moments of a U- statistic		
	9	Projection of a U-statistic on the basic observations		
	10	Almost sure behavior of U-statistics		
	11	Asymptotic distribution theory of U-statistics		
	12	Non-parametric density estimation		
III	**Univariate stochastic orders**		**12**	**20**
	13	Usual stochastic order		
	14	Hazard rate order		
	15	Likelihood ratio order		
	16	Convolution order		
	17	Mean residual life orders		
IV	**Univariate variability orders**		**12**	**15**
	18	Convex order, dispersive order,		
	19	Excess wealth order & peakedness order		
	20	Monotone convex and monotone concave orders		
	21	Transform orders: convex, star orders		
	22	Super additive orders		
V	**Practical applications of the advanced trends in statistics**		**12**	
	Practical applications of the concepts discussed in Module I to Module IV			

References

1. Laha, R.G. and Rotatgi, V.K. (1979). Probability Theory. Wiley, New York.
2. Serfling, R.J.(1980). Approximation Theorems of Mathematical Statistics (Chapter-5). John Wiley and Sons, Canada.
3. Steutel, F.W. and van Harn, K. (2004). Infinite Divisibility of Probability Distributions on the Real Line. Marcel Dekker Inc., New York.
4. Shaked, M. and Shanthikumar, J. G. (Eds.). (2007). Stochastic Orders. Springer, New York.

MINOR COURSES IN STATISICS

SYLLABUS

	**ST. THOMAS COLLEGE (AUTONOMOUS)** **THRISSUR**
	Four Year UG Program Syllabus - Minor

Programme	BSc Statistics				
Course Code	STA1MN101				
Course Title	Descriptive Statistics for Data Science				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of data, variables, charts and graphs, Basic computer skills				
Course Summary	This course aims to equip students with a holistic understanding of different data types and probability, enabling them to make informed decisions and draw meaningful conclusions from data.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the basic terms and types of variables in statistics.	Understanding	Conceptual Knowledge	Quiz, Assignment
CO2	Conduct a comprehensive collection of primary and secondary data.	Applying	Procedural Knowledge	Project, Practical
CO3	Analyze frequency distributions and cumulative frequency distributions.	Analyzing	Conceptual Knowledge	Exam, Assignment
CO4	Calculate and interpret measures of central tendency and dispersion.	Applying	Procedural Knowledge	Quiz, Project
CO5	Apply probability concepts, including Baye's theorem, in problem-solving.	Creating	Conceptual Knowledge	Exam, Practical

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**INTRODUCTION TO STATISTICS**		**8**	**10**
	1	Basic terms and types of Variables	2	
	2	Collection of data- Primary and secondary data,	2	
	3	Methods of collecting primary data	2	
	4	Sources of Secondary data	2	
II	**ORGANIZING AND GRAPHING DATA**		9	**15**
	5	Frequency Distribution	2	
	6	Cumulative Frequency distribution	2	
	7	Diagrammatic Representations	3	
	8	Graphical Representation of data	2	

III	**NUMERICAL DESCRIPTIVE MEASURES**		**12**	**25**
	9	Measures of central tendency	1	
	10	Arithmetic Mean	2	
	11	Median and Mode	2	
	12	Geometric mean and Harmonic Mean	2	
	13	Partition values	1	
	14	Measures of dispersion	3	
	15	Skewness and Kurtosis (Concept only)	1	
IV	**PROBABILITY**		**16**	**20**
	16	Random Experiment, Sample Space, Events (Basic terminology), Three Conceptual Approaches to Probability	2	
	17	Addition theorem (for two and three events) and simple problems	2	
	18	Conditional probability	3	
	19	Multiplication theorem of probability	2	
	20	Independent events and its Multiplication Theorem	2	
	21	Pairwise and mutual independence (Concept and Problems)	2	
	22	Baye's theorem	3	
V	**Spreadsheet-Based Practice Problems on Data Analysis and Visualization**		**30**	
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Types of data		
	2	Introduction to spreadsheet		
	3	Frequency distributions for organizing and summarizing data		
	4	Histograms		
	5	Graphs that enlighten and graphs that deceive		
	6	Measures of central tendency		
	7	Measures of dispersion		
	8	Measures of Relative Standing and Boxplots		

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th edition, Sulthan Chand, New Delhi
2. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House.
3. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
4. Neil A. Weiss, Introductory Statistics, 9th Edition, Addison Wesley Pearson Learning (2011)
5. Mario F Triola, Elementary Statistics using Excel, (2018), 6th edition.

Mapping of COs with POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3			2			
CO2		3			2		
CO3			3			2	
CO4		2		2			
CO5	2				3		

Programme	BSc Statistics				
Course Code	STA2MN101				
Course Title	Probability theory I				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Students should have a strong foundation in algebra and calculus, including functions, differentiation, and integration. Basic knowledge about descriptive Statistics				
Course Summary	Students will acquire a comprehensive understanding of key statistical concepts; random variable, standard theoretical distributions and sampling distributions.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain discrete random variables and their probability mass function.	Understanding	Conceptual Knowledge	Quiz, Assignment
CO2	Calculate mathematical expectation, variance, and covariance of random variables.	Applying	Procedural Knowledge	Quiz, Problem Set
CO3	Analyze properties of cumulative distribution functions and their applications.	Analyzing	Conceptual Knowledge	Case Study, Assignment
CO4	Apply the concepts of probability density functions to continuous random variables.	Applying	Procedural Knowledge	Quiz, Practical Examination
CO5	Evaluate the effectiveness of simple regression models and coefficients of determination.	Evaluating	Procedural Knowledge	Project, Presentation

Detailed Syllabus:

Module	Units	Content	Hrs (45 +30)	Marks (70)
I	**DISCRETE RANDOM VARIABLES AND THEIR PROBABILITY DISTRIBUTIONS**		12	15
	1	Random Variables- Discrete	1	
	2	Probability mass function, properties and problems	1	
	3	Cumulative distribution function and its properties	1	

	4	Mathematical expectation of a random variable, function of a random variable and properties of expectation	1	
	5	Properties of variance	1	
	6	Covariance	2	
	7	Moments (definition only), Moment Generating Function (Definition, Simple problems and Properties (without proof))	1	
	8	Binomial Distribution (Mean, variance, m.g.f.,Simple Problems)	2	
	9	Poisson Distribution (Mean, variance, m.g.f.,Simple Problems)	2	
II	**CONTINUOUS RANDOM VARIABLES AND THEIR PROBABILITY DISTRIBUTIONS**		12	20
	10	Probability density function, properties and problems	2	
	11	Rectangular distribution (Mean and Variance)	2	
	12	Exponential distribution (Mean and Variance)	2	
	13	Normal Distribution (Moments, Moment Generating Function, Additive Property ,Area property and their problems)	6	
III	**DESCRIPTIVE METHODS IN CORRELATION AND REGRESSION**		10	20
	14	Simple correlation	3	
	15	Simple regression	3	
	16	Coefficient of determination	2	
	17	Curve linear regression	2	
IV	**SAMPLING DISTRIBUTIONS**		11	15
	18	Parameter and Statistic, sampling distribution, standard error.	2	
	19	Distribution of sample mean	2	
	20	Chi- square distribution (definition, mean, variance, m.g.f, additive property)	4	
	21	F distribution (definition only)	1	
	22	t distribution	2	
V	**Spreadsheet Practice Problems on Statistical Analysis and Probability**		30	
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Scatterplot and correlation		

	2	Linear correlation coefficient r		
	3	Regression		
	4	Calculate factorials, permutations and combinations		
	5	Concept of simulation		
	6	Finding mean and variance of a probability distribution		
	7	Methods for finding binomial probabilities		
	8	Methods for finding Poisson probabilities		

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics, 11th edition, Sulthan Chand, New Delhi
2. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Neil A. Weiss, Introductory Statistics, 9th Edition ,Addison Wesley Pearson Learning (2011)
5. Mario F Triola, Elementary Statistics using Excel, (2018), 6th edition.

Mapping of COs with POs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3			2	1		
CO2	1	3			2		
CO3			3		2	1	
CO4		3		2			
CO5	2				3		

Programme	BSc Statistics				
Course Code	STA3MN201				
Course Title	Statistical inference using R				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Students should be comfortable with concepts such as probability distributions, random variables, and conditional probability.				
Course Summary	Upon completion of this course, students will be proficient in understanding and applying the concept of estimation and testing of hypothesis in statistics, allowing them to make informed decisions and draw reliable conclusions from sample data.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the theory of estimation, including point estimation and methods of estimation.	Understanding	Conceptual Knowledge	Assignments
CO2	Calculate confidence limits for means and proportions based on interval estimation.	Applying	Procedural Knowledge	Quizzes
CO3	Analyze statistical hypotheses, including null and alternate hypotheses and types of errors.	Analyzing	Conceptual Knowledge	Exams
CO4	Evaluate the applications of the Chi-square test for goodness of fit and independence.	Evaluating	Evaluative Knowledge	Projects
CO5	Use R for statistical analysis, including data input and graphical representations.	Applying	Procedural Knowledge	Practical

Detailed Syllabus:

Module	Units	Content	Hrs (45 +30)	Marks (70)
I	**THEORY OF ESTIMATION**		14	25
	1	Point estimation	1	
	2	Unbiasedness	2	
	3	Consistency	2	
	4	Efficiency	2	

	5	Sufficiency	2	
	6	Methods of estimation	2	
	7	Interval estimation	1	
	8	Confidence limits for mean	1	
	9	Confidence limits for proportion	1	
II	**TESTING OF HYPOTHESIS**		10	20
	10	Statistical hypothesis, Simple and composite hypothesis	2	
	11	Null and alternate hypothesis, Two types of errors, Level of significance, Critical region, one tailed and two tailed tests	2	
	12	Large sample tests: Test for single proportion	3	
	13	Test of significance for a single mean	3	
III	**CHI SQUARE TEST**		9	15
	14	Applications of Chi square distribution	2	
	15	Chi square test of goodness of fit	3	
	16	Chi square test for independence of attributes	4	
IV	**INTRODUCTION TO R**		12	10
	17	Installation & Basic Mathematical Operations	2	
	18	R Preliminaries	1	
	19	Methods of Data Input	1	
	20	Graphical Representations (R Code)	2	
	21	Diagrammatic Representations (R Code)	3	
	22	Descriptive Measures (Mean, Median, Mode, Range, Standard deviation, variance)	3	
V	**Practical Exercises in R: Statistical Analysis and Data Visualization**		30	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Basic mathematical operations and R preliminaries		
	2	Methods of data input		
	3	Data accessing or indexing		
	4	Built in functions in R		

	5	Graphical representations (R Code)		
	6	Diagrammatic representations (R Code)		
	7	Mean, Median, Mode		
	8	Range, Standard deviation, variance		

Books and References:

1. Gupta, S. C.. (2015). Fundamentals of Statistics, Himalaya Publishing House.
2. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics, 11th edition, Sulthan Chand, New Delhi
3. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
4. The R book (2007) , Michael J. Crawley John Wiley Series
5. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R

Mapping of COs with POs :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3			2	3		
CO2		3			2		
CO3	2		3		2		
CO4	3				3		
CO5		2		2	3		

Programme	BSc Statistics				
Course Code	STA1MN102				
Course Title	Applied statistics using R				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic Knowledge in the Descriptive Measures				
Course Summary	Upon successful completion of this course, students will possess a solid understanding of fundamentals of sampling concepts, index numbers, vital statistics and R software.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of sampling methods, including population, sample, and types of sampling.	Understanding	Conceptual Knowledge	Assignments
CO2	Analyze the advantages and limitations of various sampling techniques in survey methods.	Analyzing	Conceptual Knowledge	Quizzes
CO3	Apply methods for constructing index numbers and evaluate their significance.	Applying	Procedural Knowledge	Projects
CO4	Evaluate vital statistics, including measures of fertility and mortality, and their collection methods.	Evaluating	Evaluative Knowledge	Exams
CO5	Utilize R for data input and graphical representations in statistical analysis.	Applying	Procedural Knowledge	Practical

Detailed Syllabus:

Module	Units	Content	Hrs (45 +30)	Marks (70)
I	**SAMPLING METHODS**		10	15
	1	Population and Sample, Census and Sampling Method	1	
	2	Advantages and Limitations of Sampling	1	
	3	Principal steps in a sample survey	1	
	4	Sampling and Non-Sampling Errors	1	

	5	Types of sampling (Purposive, Probability, Mixed)	1	
	6	Simple Random Sampling (Concept and Method of Selection)	2	
	7	Stratified Random Sampling	2	
	8	Systematic Random Sampling	1	
II	**INDEX NUMBERS**		10	25
	9	Introduction and Uses of Index Numbers	1	
	10	Types of Index Numbers	1	
	11	Problems in the construction of Index Number	1	
	12	Methods of Construction of Index Numbers- Simple and Weighted Index Number	5	
	13	Tests for an Ideal Index Number- Time Reversal Test and Factor Reversal Test	2	
III	**VITAL STATISTICS**		11	20
	14	Introduction to Vital Statistics	1	
	15	Uses of Vital Statistics	2	
	16	Collection of Vital Statistics-Registration Method, Census Enumeration Method, Survey Method, Analytical Method	2	
	17	Measures of Fertility –Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (ASFR). Total Fertility Rate (TFR) (Concept and Problems)	3	
	18	Measurement of Mortality- Crude Death Rate (CDR), Specific Death Rate (ASDR), Standardized Death Rate (SDR), Infant Mortality Rate, Maternal Mortality Rate(Concept and Problems)	3	
IV	**INTRODUCTION TO R**		14	10
	19	Installation & Basic Mathematical Operations	1	
	20	R Preliminaries	1	
	21	Methods of Data Input	1	
	22	Graphical Representations (R Code)	4	
	23	Diagrammatic Representations (R Code)	3	
	24	Descriptive Measures (Mean, Median, Mode, Range,	4	
		Standard deviation, variance)		
	Hands-on R Practice: Data Manipulation, Analysis, and			

	Visualization			
V	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.		30	
	1	Basic mathematical operations and R preliminaries		
	2	Methods of data input		
	3	Data accessing or indexing		
	4	Built in functions in R		
	5	Graphical representations (R Code)		
	6	Diagrammatic representations (R Code)		
	7	Mean, Median, Mode		
	8	Range, Standard deviation, variance		

Books and References:

1. Gupta, S. C.. (2015). Fundamentals of Statistics, Himalaya Publishing House
2. Gupta S.P (2021), Statistical Methods, 46 th edition, Sultan Chand and Sons.
3. Gupta, S. C. and Kapoor, V. K. (2014). Fundamentals of applied Statistics, Sultan Chand and Sons.
4. The R book(2007) , Michael J. Crawley John Wiley Series
5. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R

Mapping of COs with POs:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3			2			
CO2		2	3				
CO3	2				3		
CO4			2			3	
CO5		2		2			

Programme	BSc Statistics				
Course Code	STA2MN102				
Course Title	Probability theory II				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic Knowledge in the concept of Probability and Random Variables				
Course Summary	Students will possess a comprehensive understanding of bivariate random variables, enabling them to analyze and interpret the joint behavior of two random variables.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of two-dimensional random variables and their distributions.	Understanding	Conceptual Knowledge	Assignments
CO2	Analyze joint probability mass functions (PMFs) and probability density functions (pdfs) for two-dimensional random variables.	Analyzing	Conceptual Knowledge	Quizzes
CO3	Apply the concepts of covariance and correlation coefficients in the analysis of bivariate data.	Applying	Procedural Knowledge	Projects
CO4	Evaluate standard distributions, including their mean, variance, and moment-generating functions.	Evaluating	Evaluative Knowledge	Exams
CO5	Utilize time series analysis techniques to measure trends and seasonal variations in data.	Applying	Procedural Knowledge	Practical

Detailed Syllabus:

Module	Units	Content	Hrs (45 +30)	Marks (70)
I	**TWO DIMENSIONAL RANDOM VARIABLES**		11	20
	1	Introduction to two dimensional random variables	1	
	2	Joint PMF and Joint pdf (Concept and Problems)	2	
	3	Joint DF(Concept and Problems)	2	

	4	Marginal Distributions(Concept and Problems)	2	
	5	Conditional Distributions(Concept and Problems)	3	
	6	Independence of Random Variables(Concept and Problems)	1	
II		**BIVARIATE EXPECTATION**	12	15
	7	Expectation of two random variables (Concept and Problems),Addition Theorem (Statement Only), Multiplication Theorem (Statement Only)	3	
	8	Properties of Variance	1	
	9	Covariance & Correlation Coefficient	3	
	10	Conditional Expectation and Conditional Variance (Concept and Problems)	5	
III		**STANDARD DISTRIBUTIONS**	12	15
	11	Discrete Uniform Distribution (Mean, variance, mgf,	1	
		Problems)		
	12	Geometric Distribution (Mean, variance, mgf, Problems)	1	
	13	Hypergeometric Distribution (Mean, variance, mgf, Problems)	1	
	14	Negative Binomial Distribution (Mean, variance, mgf, Problems)	1	
	15	Rectangular Distribution(Mean, variance, mgf, Problems)	2	
	16	Gamma Distribution(Mean, variance, mgf, Problems)	2	
	17	Beta Distribution(Mean, variance, mgf, Problems)	2	
	18	Order Statistics[Distribution function of single order statistic ,Examples]	2	
IV		**TIME SERIES ANALYSIS**	10	20
	19	Introduction to Time Series & Utility of Time Series	1	
	20	Components of Time Series	1	
	21	Measurement of Trend- Graphic Method, Semi Average Method, Method of Moving Average, Method of Least squares (Linear Trend) (Concept and Problems)	4	
	22	Measurement of Seasonal Variations-Method of Simple Averages ,Ratio to Trend Method	4	
V	**R Practice Problems on Skewness, Kurtosis, and Probability Distributions**		30	

	Do practice problems in R software from any 5 units of the given list			
	and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Measures of skewness		
	2	Measures of kurtosis		
	3	Obtain the probability distribution		
	4	Plot the probability distribution		
	5	Obtain the cumulative distribution function		
	6	Plot the cumulative distribution function		
	7	Obtain any one discrete probability		
	8	Obtain any one continuous probability		

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th edition, Sulthan Chand, New Delhi
2. Gupta, S. C.. (2015). Fundamentals of Statistics. **,** & 7th edition, Himalaya Publishing House 3.Gupta S.C (2021), Statistical Methods, 46 th edition, Sultan Chand and Sons.

4.The R book(2007) , Michael J. Crawley John Wiley Series

5 Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh ,Statistics Using R(2015)

Mapping of COs with POs :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3			2			
CO2		2	3				
CO3	2				3		
CO4			2			3	
CO5		2		2			

Programme	BSc Statistics				
Course Code	STA3MN202				
Course Title	Statistical inference for data science				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Thorough knowledge in probability concept and Random variables.				
Course Summary	Students will possess a wide understanding of Law of Large Numbers, ANOVA, and non-parametric tests and they will be equipped to apply these statistical techniques to various scenarios, making informed decisions and drawing meaningful conclusions from data.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the Law of Large Numbers and its implications in probability theory.	Understanding	Conceptual Knowledge	Assignments
CO2	Apply Chebyshev's inequality and modes of convergence to evaluate random variables.	Applying	Procedural Knowledge	Quizzes
CO3	Analyze hypothesis testing methods for differences between two population means and proportions.	Analyzing	Conceptual Knowledge	Projects
CO4	Evaluate the effectiveness of ANOVA in comparing means across multiple populations.	Evaluating	Evaluative Knowledge	Exams
CO5	Implement non-parametric tests, including the Wilcoxon Signed Rank Test and Mann-Whitney Test, in statistical analysis.	Applying	Procedural Knowledge	Practical

Detailed Syllabus:

Module	Units	Content	Hrs (45 +30)	Marks (70)
I		**LAW OF LARGE NUMBERS**	10	15
	1	Chebychev's inequality (Definition and Problems)	2	
	2	Modes of Convergence of a Sequence of Random Variables	1	
	3	Weak Law of Large Numbers (Statement and Problems)	2	
	4	Bernoulli's Law of Large Numbers		

	5	Strong Law of Large Numbers	2	
	6	CLT (Lindeberg- Levy)	3	
II	**HYPOTHESIS TESTING: TWO POPULATIONS**		12	20
	6	Test of Significance for difference of two population proportions (Concept and Problems)	2	
	7	Test of Significance for difference of two population means (Large Sample-Concept and Problems)	2	
	8	Test of Significance for difference of two population means (Small Sample-Concept and Problems)	3	
	9	Paired t test(Concept and Problems)	3	
	10	F test for equality of proportions	2	
III	**ANALYSIS OF VARIANCE**		8	15
	11	ANOVA	1	
	12	One-Way Analysis of Variance	3	
	13	Two -Way Analysis of Variance	4	
IV	**NON-PARAMETRIC TEST**		15	20
	14	Introduction to Non Parametric Methods	1	
	15	Advantages and Limitations	1	
	16	Sign Test- one sample	3	
	17	Wilcoxon Signed Rank Test	2	
	18	Mann- Whitney Test	2	
	19	Kruskal- Wallis Test	2	
	20	Single Sample Run Test	2	
	21	Median Test	2	
V	**R Practice Exercises on Statistical Inference and Regression Analysis**		30	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Plots to check normality		
	2	Hypothesis testing		
	3	Goodness of fit tests		
	4	Correlation		
	5	Inference procedures for correlation coefficient		
	6	Linear regression		
	7	Inference procedures for simple linear model		
	8	Polynomial regression models		

Books and References:
1. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. , 11th edition, Sulthan Chand, New Delhi.
2. Gupta, S. C. (2015). Fundamentals of Statistics,7 th Edition, Himalaya Publishing House.
3. Gupta S.C (2021), Statistical Methods, 46 th edition, Sultan Chand and Sons.
4. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
5. W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R (2023)
6. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R

Mapping of COs with POs :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3						
CO2		2					
CO3			3				
CO4				3			
CO5		2			2		

Programme	BSc Statistics				
Course Code	STA1MN103				
Course Title	Introductory statistics with R				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge about data, basic mathematical knowledge				
Course Summary	This course covers data types, distributions, graphs, and statistical measures using R programming. Students learn to analyze data effectively for informed decision-making across diverse domains.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the different types of data including primary, secondary, quantitative, and qualitative.	Understanding	Conceptual Knowledge	Assignments
CO2	Construct frequency distributions and cumulative frequency distributions for given datasets.	Applying	Procedural Knowledge	Quizzes
CO3	Analyze and interpret various graphical representations of data, such as histograms and pie charts.	Analyzing	Conceptual Knowledge	Projects
CO4	Compute measures of central tendency, including arithmetic mean, median, and mode, for data analysis.	Applying	Procedural Knowledge	Exams
CO5	Implement basic R programming techniques to import, export, and visualize data using R functions and packages.	Applying	Procedural Knowledge	Practical

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Data**		**12**	**15**
	1	Types of data: Primary data, Secondary data, Quantitative data, Qualitative data, discrete data, continuous data	4	
	2	Frequency distribution: Ungrouped and grouped	4	
	3	Cumulative frequency distribution	4	
II	**Graphical representation of data**		**9**	**15**
	4	Line diagram, Bar diagram	3	
	5	Pictogram, Pie diagram, Histogram	3	
	6	Frequency Polygon, Frequency curve, Ogives.	3	
III	**Measures of central tendency**		**10**	**25**

	7	Arithmetic Mean	2	
	8	Median	2	
	9	Mode	2	
	10	Geometric mean	2	
	11	Harmonic mean	2	
IV	**Introduction to R programming**		**14**	**15**
	12	Installing R	1	
	13	Objects in R	1	
	14	Using functions in R	1	
	15	Importing data	1	
	16	Exporting data	1	
	17	Simple base R plots	2	
	18	Multiple graphs	2	
	19	R packages	1	
	20	Exporting plots	2	
	21	Getting help	1	
	22	Saving stuff in R	1	
V	**R Programming Practice: Functions, Loops, and Conditional Statements**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Functions in R— data.frame		
	2	multiply_columns()		
	3	return()		
	4	identical()		
	5	Conditional statements-if and else		
	6	Combining logical operators		
	7	For loop		
	8	While loop		

Books and References:

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. Douglas, Alex, Deon Roos, Francesca Mancini, Ana Couto, and David Lusseau. (2020), *An Introduction to R*. https://intro2r.com/index.html.
3. S.C. Gupta, Fundamentals of Statistics, Himalaya Publishing house

Mapping of COs with POs :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		2					
CO3			3				
CO4		2					
CO5		2			2		

Programme	BSc Statistics				
Course Code	STA2MN103				
Course Title	Regression and probability theory				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge about set theory, fundamental concepts of data				
Course Summary	This course covers dispersion, correlation, regression, and probability theory with practical applications using R programming, enhancing students' statistical skills for diverse scenarios.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain measures of dispersion, including range, quartile deviation, standard deviation, and coefficient of variation.	Understanding	Conceptual Knowledge	Assignments
CO2	Calculate and interpret the range, quartile deviation, and standard deviation for given datasets.	Applying	Procedural Knowledge	Quizzes
CO3	Analyze the relationship between two variables using bivariate distribution and the correlation coefficient.	Analyzing	Conceptual Knowledge	Projects
CO4	Construct and interpret scatter diagrams, regression lines, and regression coefficients for data analysis.	Applying	Procedural Knowledge	Exams
CO5	Describe fundamental concepts of probability theory, including random experiments, sample spaces, and events.	Understanding	Conceptual Knowledge	Practical

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Measures of dispersion**	**10**	**10**
	1	Range	1	
	2	Quartile deviation	3	
	3	Standard deviation	3	
	4	Coefficient of variation	3	
II		**Correlation and regression**	**13**	**20**

	5	Bivariate distribution, correlation	1	
	6	Scatter diagram	2	
	7	Karl Pearson coefficient of correlation	2	
	8	Limits of Correlation coefficient	2	
	9	Regression	2	
	10	Lines of regression	3	
	11	Regression coefficients	2	
III	**Probability theory**		**10**	**25**
	12	Random experiment	1	
	13	Sample space	1	
	14	Event	1	
	15	Classical Probability-definition	2	
	16	Statistical probability-definition	2	
	17	Axiomatic approach to Probability	2	
	18	Addition theorem (Statement only)	1	
IV	**Conditional Probability**		**12**	**15**
	18	Conditional Probability of two events	3	
	19	Multiplication theorem (Statement only)	2	
	20	Independence of events	2	
	21	Conditions of mutual independence of three events	2	
	22	Bayes theorem and its applications (Statement only)	3	
V	**R Practice Problems: Correlation, Graphical Representations, and Statistical Measures**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	cor() function		
	2	Use of cor() function with missing values in data		
	3	ggplot		
	4	Diagrammatic representation of data		
	5	Graphical representation of data		
	6	Measures of central tendency (Any two)		
	7	Measures of dispersion (Any two)		
	8	Any two exercises of above		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Douglas, Alex, Deon Roos, Francesca Mancini, Ana Couto, and David Lusseau. (2020), *An Introduction to R*. https://intro2r.com/index.html.
4. Sudha G. Purohit (2008), Statistics using R, Alpha Science International

Mapping of COs with POs :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		2					
CO3			3				
CO4		2					
CO5	3						

Programme	BSc Statistics				
Course Code	STA3MN203				
Course Title	Random variables and CART				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of set theory and probability theory				
Course Summary	This course offers a comprehensive understanding of random variables, distributions, and statistical learning methods like classification and regression trees, bagging, random forest, with hands-on experience in R				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the concept of random variables and their associated distribution functions.	Understanding	Conceptual Knowledge	Assignments
CO2	Differentiate between discrete and continuous random variables, including their probability functions.	Analyzing	Conceptual Knowledge	Quizzes
CO3	Apply standard distributions such as Bernoulli, Binomial, Poisson, and Normal in statistical analysis.	Applying	Procedural Knowledge	Projects
CO4	Explain the fundamentals of statistical learning, including input/output, response/predictor variables, and learning types.	Understanding	Conceptual Knowledge	Exams
CO5	Evaluate the advantages and disadvantages of classification and regression trees in statistical learning.	Evaluating	Conceptual Knowledge	Practical

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Random variables**		**14**	**20**
	1	Random variable	2	
	2	Distribution function	2	
	3	Discrete random variable	2	
	4	Probability mass function	2	
	5	Discrete distribution function	2	
	6	Continuous random variable	2	

	7	Probability density function	2	
II	**Standard distributions**		**15**	**20**
	8	Bernoulli distribution	2	
	9	Binomial distribution	4	
	10	Poisson distribution	4	
	11	Normal distribution	4	
	12	Importance of Normal distribution	1	
III	**Statistical learning**		**10**	**20**
	13	An introduction to Statistical learning	1	
	14	Input and output variables	1	
	15	Response and predictor variables	1	
	16	Supervised and unsupervised learning	1	
	17	Classification verses regression	1	
	18	Classification and regression trees (CART)	2	
	19	Trees versus linear models	2	
	20	Advantages and disadvantages of trees	1	
IV	**Bagging**		**6**	**10**
	21	An introduction to Bagging	3	
	22	Random forest	3	
V	**R Practice Problems: Classification Trees, Regression, and Model Evaluation**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Fitting classification trees		
	2	Pruning trees		
	3	Use the function–lm.fit		
	4	Use the function–names()		
	5	Use the function–predict()		
	6	Plotting of least square regression line-abline()		
	7	Plotting of least square regression line- plot()		
	8	residuals() function		

Books and References:

1. G. James, D. Witten, T. Hastie, and R. Tibshirani. (2013), An Introduction to Statistical Learning: with Applications in R, Springer.
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi

Mapping of COs with POs :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4	3						
CO5				3			

Programme	BSc Statistics				
Course Code	STA1MN104				
Course Title	Applied statistics				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic mathematical knowledge about calculus, introductory knowledge about data				
Course Summary	Gain a solid understanding of statistical concepts such as measurement scales, sampling methods, index numbers, and time series analysis, alongside practical applications, while acquiring hands-on data analysis skills using statistical software.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the principles of statistical surveys, including planning, purpose, and scope.	Understanding	Conceptual Knowledge	Assignments
CO2	Analyze different types of sampling methods, including purposive, random, and stratified sampling.	Analyzing	Conceptual Knowledge	Quizzes
CO3	Evaluate the construction and interpretation of index numbers and their significance in statistics.	Evaluating	Conceptual Knowledge	Projects
CO4	Apply measures of fertility and mortality in the context of vital statistics.	Applying	Procedural Knowledge	Exams
CO5	Describe the components and methods for analyzing time series data, including trend measurement.	Understanding	Conceptual Knowledge	Practical

Detailed Syllabus:

Module	Unit	Content	Hrs (48+30)	Marks (70)
I	**Data and questionnaire**		**9**	**15**
	1	Statistical Survey—An Introduction	1	
	2	Planning the Survey	1	
	3	Specification of the Purpose	1	
	4	Scope of the Survey	1	
	5	Sources of Data	2	

	6	Methods of collecting primary data	2	
	7	Drafting the questionnaire	1	
II	**Sample Survey**		**10**	**15**
	4	Introduction	1	
	5	Types of sampling	2	
	6	Purposive sampling	2	
	7	Random sampling	1	
	8	Simple sampling	2	
	9	Stratified sampling	2	
	Unit 1: 12.1 Ref[2]			
III	**Index numbers and Vital Statistics**		**16**	**20**
	7	Introduction and Uses of Index Numbers	1	
	8	Types of Index Numbers	1	
	9	Problems in the construction of Index Number	1	
	10	Methods of Construction of Index Numbers- Simple and Weighted Index Number	1	
	11	Tests for an Ideal Index Number- Time Reversal Test and Factor Reversal Test	2	
	12	Introduction to Vital Statistics	1	
	13	Uses of Vital Statistics	1	
	14	Collection of Vital Statistics-Registration Method, Census Enumeration Method, Survey Method, Analytical Method	2	
	15	Measures of Fertility –Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (ASFR). Total Fertility Rate (TFR) (Concept and Problems)	3	
	16	Measurement of Mortality- Crude Death Rate (CDR), Specific Death Rate (ASDR), Standardized Death Rate (SDR), Infant Mortality Rate, Maternal Mortality Rate(Concept and Problems)	3	
IV	**Time series**		**10**	**20**
	17	Introduction to Time Series & Utility of Time Series	1	
	18	Components of Time Series	1	
	19	Measurement of Trend- Graphic Method	2	
	20	Semi Average Method	2	
	21	Method of Moving Average(Concept and Problems)	2	
	22	Measurement of Seasonal Variations-Method of Simple Averages	2	
V	**Practical Exercises on Data Analysis, Sampling, and Error Reduction Techniques**		**30**	
	Do practice problems using any software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			

	1	Problems on graphic method		
	2	Problems on Semi average method		
	3	Problems on Moving average		
	4	Problems on method of Simple averages		
	5	Determination of sample size in sampling		
	6	Sampling errors		
	7	Method of reducing sampling errors		
	8	Non sampling errors		

Books and References:

1. S.P Gupta (2021),Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Gupta, S. C.. (2015). Fundamentals of Statistics, Himalaya Publishing House

Mapping of COs with POs :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5	3						

Programme	BSc Statistics				
Course Code	STA2MN104				
Course Title	Regression using JASP software				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic understanding of statistical concepts, familiarity with algebraic concepts				
Course Summary	Covering advanced statistical concepts like skewness, kurtosis, multiple regression, and JASP software utilization, alongside developing skills in descriptive statistics, data manipulation, result interpretation, and understanding sampling distributions and test statistics using JASP.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define and explain the concepts of skewness and kurtosis, including their measures.	Understanding	Conceptual Knowledge	Assignments
CO2	Apply multiple regression techniques to analyze the relationship between multiple variables.	Applying	Procedural Knowledge	Projects
CO3	Analyze the assumptions of linear multiple regression and evaluate their significance.	Analyzing	Conceptual Knowledge	Quizzes
CO4	Utilize JASP statistical software to calculate descriptive statistics such as mean, median, and variance.	Applying	Procedural Knowledge	Practical
CO5	Explain the characteristics and applications of chi-square, t, and F distributions in sampling distributions.	Understanding	Conceptual Knowledge	Exams

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Skewness and Kurtosis**		**8**	**10**
	1	Skewness	2	
	2	Kurtosis	2	
	3	Pearson’s measure of skewness	2	
	4	Percentile measure of Kurtosis	2	
II	**Multiple regression**		**12**	**25**

	5	Multiple regression	1	
	6	Multiple Regression and Correlation Analysis	1	
	7	Assumptions of Linear Multiple Regression Analysis	1	
	8	Coefficient of Multiple Determination	1	
	9	Partial correlation	1	
	10	Partial correlation coefficient	2	
	11	The Significance of a Partial Correlation Coefficient	1	
	12	Multiple correlation	1	
	13	Coefficient of Multiple Correlation	1	
	14	Advantages of Multiple Correlation Analysis	1	
	15	Limitations of Multiple Correlation Analysis	1	
III	**JASP statistical software**		**13**	**20**
	16	Installing JASP	2	
	17	Loading data in JASP	2	
	18	Changing data from one measurement scale to another	3	
	19	Calculating Mean, Median and Mode in JASP	3	
	20	Calculating Range, standard deviation and variance using JASP	3	
IV	**Sampling distributions**		**12**	**15**
	21	Chi-square distribution	4	
	22	Student's t distribution	4	
	23	F distribution	4	
V	**JASP Practice Problems: Correlation, Regression, and Model Selection**		**30**	
	Do practice problems in JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Problems on plotting scatter plots		
	2	Correlation calculation		
	3	Interpretation of correlation coefficient in JASP		
	4	Finding Rank correlation		
	5	Introduce correlation matrix in JASP		
	6	Linear regression model		
	7	Model checking		
	8	Model selection		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners. (Version 1/(√2)).

Mapping of COs with POs :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5	3						

Programme	BSc Statistics				
Course Code	STA3MN204				
Course Title	Tests of hypothesis and SVM				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Familiarity with algebraic concepts, basic statistics and probability concepts. Understanding of data visualization methods.				
Course Summary	Explore hypothesis testing basics like null and alternative hypotheses, critical regions, significance levels, and one/two-tailed tests, alongside t-tests, chi-square tests, and support vector machines, emphasizing practical applications with R				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of null and alternative hypotheses, including errors in hypothesis testing.	Understanding	Conceptual Knowledge	Quizzes, Assignments
CO2	Apply appropriate tests of significance, including one-tailed and two-tailed tests, to real data.	Applying	Procedural Knowledge	Practical Exams
CO3	Analyze the results of chi-square tests for goodness of fit and independence of two attributes.	Analyzing	Conceptual Knowledge	Case Studies
CO4	Describe the assumptions and techniques used in one-way ANOVA.	Understanding	Conceptual Knowledge	Written Exams
CO5	Construct and evaluate a maximal margin classifier using support vector machines for classification tasks.	Applying	Procedural Knowledge	Project Work

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Testing of hypothesis**	**10**	**15**
	1	Tests of significance-Introduction	1	
	2	Null hypothesis	2	
	3	Alternative hypothesis	2	
	4	errors in hypothesis testing	2	
	5	Critical region and Level of Significance	2	

	6	One and two tailed tests	1	
II	**Small and Large sample tests**		**9**	**15**
	7	Steps for testing of hypothesis	1	
	8	t test for single mean	4	
	9	t test for difference of means	4	
III	**Chi square tests and ANOVA**		**18**	**25**
	10	Chi square tests for Goodness of fit	3	
	11	Chi square test for independence of two attributes	3	
	12	Introduction to Analysis of variance	2	
	13	Assumptions	1	
	14	Techniques of ANOVA	4	
	15	One way ANOVA	5	
IV	**Support vector machine**		**8**	**15**
	16	Definition of hyperplane	1	
	17	Classification using separating hyperplane	1	
	18	Maximal margin classifier	1	
	19	Construction of Maximal Margin Classifier	2	
	20	Non separable case	1	
	21	An overview on support vector classifier	1	
	22	A brief concept of Support vector machine	1	
V	**R and JASP Practice Problems: Regression, Random Forest, and Hypothesis Testing**		**30**	
	Do practice problems in R and JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of			
	the concepts taught in the course.			
	1	Fitting of regression trees in R		
	2	Random forest in R		
	3	Chi-square goodness of fit test in JASP		
	4	Chi-square test for independence in JASP		
	5	One sample t test in JASP		
	6	How ANOVA works in JASP		
	7	Running ANOVA in JASP		
	8	An illustrative data set		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. G. James, D. Witten, T. Hastie, and R. Tibshirani. (2013), An Introduction to Statistical Learning: with Applications in R, Springer.
4. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners. (Version).

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3			2		
CO3			3				
CO4	3			3			
CO5		3					3

Programme	B.Sc Statistics				
Course Code	STA1MN105				
Course Title	Descriptive statistics				
Type of Course	Minor				
Semester	I				
Academic	100 - 199				
Level					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Familiarity with different types of data, understanding of common data visualization techniques, basic algebraic concepts.				
Course Summary	Build a foundation in data understanding, covering primary/secondary, quantitative/qualitative data, along with graphical representation like bar diagrams, central tendency, and dispersion measures, leading to practical survey and software applications.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the differences between primary and secondary data, as well as quantitative and qualitative data.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Apply appropriate methods to classify and represent data using various diagrammatic techniques.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze frequency distributions, including cumulative frequency tables, for both discrete and continuous data.	Analyzing	Conceptual Knowledge	Exams, Case Studies
CO4	Explain measures of central tendency, including mean, median, mode, geometric mean, and harmonic mean.	Understanding	Factual Knowledge	Exams, Quizzes
CO5	Calculate and interpret measures of dispersion such as range, standard deviation, quartile deviation, and coefficient of variation.	Applying	Procedural Knowledge	Assignments, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (45+ 30)	Marks
I	**A basic idea about data**		**6**	**15**
	1	Primary and secondary data	3	
	2	Quantitative and qualitative data	1	
	3	Population and sample, Sampling and census	1	

	4	Discrete and continuous data	1	
II	**Diagrammatic representation of data**		**15**	**15**
	5	Bar diagrams, pie diagram, Pictograms	5	
	6	Four types of classification	1	
	7	Frequency distribution, discrete and continuous frequency tables	6	
	8	Terms used in a frequency distribution, Cumulative frequency tables	3	
III	**Measures of central tendency**		**14**	**20**
	9	Mean, Median, Mode	9	
	10	Geometric mean and Harmonic mean with simple applications	4	
	11	Empirical relation connecting mean, median and mode	1	
IV	**Measures of dispersion**		**10**	**20**
	12	Range, Standard deviation,	4	
	13	Quartile deviation	4	
	14	Coefficient of variation	2	
V	**JASP Software Practice: Data Handling and Descriptive Statistics**		**30**	
	Do practice problems in JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Installing JASP		
	2	Loading data in JASP		
	3	Quitting JASP		
	4	Calculating mean in JASP		
	5	Calculating Median in JASP		
	6	Calculating mode in JASP		
	7.	Calculating range in JASP		

	8	Calculating interquartile range in JASP		

Books and References:

1. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
2. S.P Gupta (2021),Statistical Methods 46 th Edition
3. Garrett, H.E. and Woodworth, R.S. (1973) Statistics in Psychology and education. Vakils, Feffer and Simons Private Ltd, Bombay.
4. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners. (Version).

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4	3						
CO5		3					

Programme	BSc Statistics				
Course Code	STA2MN105				
Course Title	Introduction to Probability				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Understanding of fundamental probability concepts. Ability to manipulate and analysze basic data sets, perform simple calculations.				
Course Summary	Deepen statistical knowledge with correlation types, regression properties, and probability theory, including the relationship between correlation and regression coefficients, alongside introducing probability concepts, random variables, and distribution functions, applied through practical exercises.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of bivariate distribution and correlation, including the use of scatter diagrams.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Apply Karl Pearson coefficient of correlation to assess the relationship between variables.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Apply rank correlation methods to assess the relationship between variables.	Applying	Procedural Knowledge	Projects, Practical Work
CO4	Describe the principles of regression, including the interpretation of regression coefficients and the relationship between correlation and regression.	Understanding	Factual Knowledge	Exams, Quizzes
CO5	Explain the foundational concepts of probability, including classical, empirical, and axiomatic approaches, as well as key terms and the addition theorem.	Understanding	Factual Knowledge	Exams, Assignments

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks 70
I	**Correlation**		**12**	**15**
	1	Bivariate Distribution, Correlation	2	
	2	Scatter Diagram	1	
	3	Karl Pearson coefficient of correlation	2	
	4	Limits for Correlation Coefficient	2	
	5	Assumptions Underlying Karl Pearson's Correlation Coefficient	1	
	6	Rank Correlation	3	
II	**Regression**		**14**	**20**
	7	Regression	2	
	8	The two regression lines	3	
	9	Regression coefficients	3	
	`10	Properties of regression coefficients	3	
	11	Relation between coefficient of correlation and regression coefficients	3	
III	**Introduction to Probability**		**10**	**15**
	12	Terms in Probability	3	
	13	Mathematical or Classical Probability	1	
	14	Statistical or Empirical Probability	1	
	15	Axiomatic approach to Probability	2	
	16	Addition theorem for two events (statement only)	1	
	17	Conditional Probability	2	
	18	Independence of events		
IV	**Random variables**		**9**	**20**
	19	Definition of random variable	2	
	20	Probability mass function	2	
	21	Probability density function	2	
	22	Distribution function	3	
V	**JASP Practice Problems: Correlation, Scatter Plots, and Regression Analysis**		**30**	
	Do practice problems in JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Problems on plotting scatter plots		
	2	Correlation calculation		
	3	Interpretation of correlation coefficient in JASP		
	4	Finding Rank correlation		
	5	Introduce correlation matrix in JASP		
	6	Linear regression model		

Books and References:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I, 8th Edn. The World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan

Chand and Sons, New Delhi
3. Garrett, H.E. and Woodworth, R.S. (1973) Statistics in Psychology and education. Vakils, Feffer and Simons Private Ltd, Bombay.
4. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners. (Version).

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4	3						
CO5	3						

Programme	BSc Statistics				
Course Code	STA3MN205				
Course Title	Inferential statistics				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Awareness of different types of data sets, basic understanding of probability theory				
Course Summary	Discover statistical testing basics, including null and alternative hypotheses, critical regions, and test statistics like z, t, F, and Chi-square, with applications such as t-tests, ANOVA, and practical software exercises.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamental concepts of hypothesis testing, including null and alternative hypotheses, errors, critical regions, and significance levels.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Analyze the properties and applications of normal distribution, including standard normal distribution and associated statistical values.	Analyzing	Conceptual Knowledge	Exams, Case Studies
CO3	Apply t-tests for single and difference of means, as well as chi-square tests for goodness of fit and independence.	Applying	Procedural Knowledge	Projects, Practical Work
CO4	Describe the assumptions and techniques of Analysis of Variance and its application in comparing means across groups.	Understanding	Factual Knowledge	Exams, Quizzes
CO5	Explain the applications of Chi-square distribution and t distribution.	Understanding	Factual Knowledge	Exams, Quizzes

Detailed Syllabus:

Module	Unit	Content	Hrs (48+30)	Marks 70
I		**Fundamentals of Testing**	**12**	**15**
	1	Tests of significance-Introduction	**2**	
	2	Null hypothesis	1	
	3	Alternative hypothesis	1	
	4	Errors in hypothesis testing	3	
	5	Critical region and Level of Significance	3	
	6	One and two tailed tests	2	
II		**Distribution Theory**	**10**	**15**
	7	Normal distribution-Properties	2	
	8	Properties of Normal distribution	1	
	9	Standard normal distribution	1	
	10	Problems with table values	2	
	11	Statistic of Chi-square distribution	2	
	12	Statistic of Student's t distribution	1	
	13	Statistic of F distribution	1	
III		**Tests of Hypothesis**	**14**	**20**
	14	Steps for testing of hypothesis	2	
	15	t test for single mean	3	
	16	t test for difference of means	3	
	17	Chi square tests for Goodness of fit	3	
	18	Chi square test for independence of two attributes	3	
IV		**Analysis of variance**	**9**	**20**
	19	Introduction to Analysis of variance	1	
	20	Assumptions	2	
	21	Techniques of ANOVA	2	
	22	One way ANOVA	4	
V		**JASP Practice Problems: Tests of Hypothesis**	**30**	
		Do practice problems using JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.		
	1	Chi-square goodness of fit test		
	2	Chi-square test for independence		
	3	One sample and independent sample t tests		
	4	One - way ANOVA		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997). Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners. (Version).

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4	3						
CO5		3					

Programme	BSc Statistics				
Course Code	STA1MN106				
Course Title	Introductory statistics with JASP				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic mathematical and computer skills. Basic knowledge of probability theory.				
Course Summary	Introduce statistical concepts with JASP software, covering data collection, questionnaire types, measurement scales, and graphical representation, while familiarizing students with installation, file manipulation, and descriptive statistics application, preparing for practical analysis in Psychology.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the process of organizing a statistical survey, including planning, purpose specification, and data sources.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Apply various methods for collecting primary data and drafting effective questionnaires for statistical surveys.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Explain the fundamentals of research design, including psychological measurement, scales of measurement, and reliability and validity assessments.	Understanding	Factual Knowledge	Exams, Quizzes
CO4	Analyze frequency distributions using various graphical representation techniques, such as histograms, frequency polygons, and ogives.	Analyzing	Conceptual Knowledge	Exams, Case Studies
CO5	Utilize JASP for statistical analysis, including data loading, changing measurement scales, and calculating descriptive statistics.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks 70
I		**Organizing a Statistical Survey**	**10**	**15**
	1	Statistical Survey—An Introduction	2	
	2	Planning the Survey	1	
	3	Specification of the Purpose	1	
	4	Scope of the Survey	1	
	5	Sources of Data	2	
	6	Methods of collecting primary data	2	
	7	Drafting the questionnaire	1	
II		**An introduction to Research Design**	**9**	**20**
	6	Introduction of Psychological measurement and variable	2	
	7	Scales of measurement	2	
	8	Accessing the reliability of measurement	3	
	9	Assessing validity of a study	2	
III		**Graphical Representation**	**15**	**20**
	9	Graphical representation of a Frequency Distribution	2	
	10	Histogram	1	
	11	Frequency Polygon	1	
	12	Ogives	3	
	13	Smoothed frequency curve	2	
	14	Technique of Constructing Graphs	2	
	15	Graphs of Time Series or Line Graphs	2	
	16	Range Chart	1	
	17	Band Graph	1	
IV		**An Introduction to JASP**	**11**	**15**
	18	Installing JASP	1	
	19	Loading data in JASP	1	
	20	Changing data from one measurement scale to another	1	
	21	Calculating Mean, Median and Mode in JASP	4	
	22	Calculating Range, standard deviation and variance using JASP	4	
V		**JASP Practice Problems: Standard Scores, Graphical Representations, and Nominal Scale Analysis**	**30**	
		Do practice problems using JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.		
	1	Standard scores in JASP		
	2	Saving image files		
	3	Histogram		
	4	Box plots		
	5	Drawing multiple box plots		

	6	Examples on Nominal scale		
	7	Examples on ordinal scale		
	8	Examples on Interval scale		
	9	Examples on Ratio scale		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2			3				
CO3	3						
CO4		3					
CO5			3				

Programme	BSc Statistics				
Course Code	STA2MN106				
Course Title	Correlation and regression				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Understanding of fundamental statistical concepts, familiarity with common data formats and basic data processing.				
Course Summary	Delve into advanced statistical techniques like skewness, kurtosis, multiple correlation, multiple regression, and R programming, equipping students to apply statistical analysis practically in real-world scenarios.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define and explain skewness and kurtosis, including Pearson's measure of skewness and percentile measures of kurtosis.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Analyze the relationship between variables using partial correlation, including the significance and calculation of partial correlation coefficients.	Analyzing	Conceptual Knowledge	Exams, Case Studies
CO3	Describe the concepts of multiple correlation and multiple regression, including their assumptions and coefficients.	Understanding	Factual Knowledge	Exams, Quizzes
CO4	Calculate the coefficient of multiple determination and evaluate the advantages and limitations of multiple correlation analysis.	Applying	Procedural Knowledge	Projects, Practical Work
CO5	Utilize R programming for data analysis, including installing R, importing/exporting data, and creating basic plots.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hours (45+30)	Marks 70
I		**Skewness and Kurtosis**	**9**	**15**
	1	Skewness	2	
	2	Kurtosis	2	

	3	Pearson's measure of skewness	3	
	4	Percentile measure of Kurtosis	2	
II	**Partial and multiple correlation**		**14**	**20**
	5	Partial correlation	2	
	6	Partial correlation coefficient	2	
	7	The Significance of a Partial Correlation Coefficient	2	
	8	Multiple correlation	2	
	9	Coefficient of Multiple Correlation	2	
	10	Advantages of Multiple Correlation Analysis	2	
	11	Limitations of Multiple Correlation Analysis	2	
III	**Multiple regression**		**12**	**20**
	12	Multiple regression	3	
	13	Multiple Regression and Correlation Analysis	3	
	14	Assumptions of Linear Multiple Regression Analysis	3	
	15	Coefficient of Multiple Determination	3	
	Introduction to R programming		**10**	**15**
	16	Installing R	1	
	17	Objects in R	1	
	18	Using functions in R	1	
	19	Importing data	1	
	20	Exporting data	1	
	21	Simple base R plots	2	
	22	Multiple graphs	3	
V	**R Software Practice: Correlation, Plot Customization, and R Studio Projects**		**30**	
	Do practice problems using R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Correlation in R		
	2	Customising plots		
	3	Simple base r plots		
	4	R packages		
	5	Installing R studio		
	6	Projects in R studio		
	7	Backing up projects		
	8	File names		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition

2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi

3. Douglas, Alex, Deon Roos, Francesca Mancini, Ana Couto, and David Lusseau. (2020), *An Introduction to R*. https://intro2r.com/index.html.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3	3						
CO4			3				
CO5			3				

Programme	BSc Statistics				
Course Code	STA3MN206				
Course Title	Tests of hypothesis with JASP software				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Familarity with common data formats, awareness of hypothesis testing concepts including null and alternate hypothesis, significance levels and p-values.				
Course Summary	Cover sampling, probability distributions, and mediation/moderation analysis, introducing JASP software for correlation, t-tests, and ANOVA. Equip students with skills for hypothesis testing, normal distribution properties, and psychological research analysis.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain various sampling methods, including purposive sampling, random sampling, simple sampling, and stratified sampling.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Apply the Simple Mediation Model to estimate direct, indirect, and total effects, and discuss the concepts of confounding and causal order.	Applying	Conceptual Knowledge	Projects, Practical Work
CO3	Analyze the advantages and disadvantages of non-parametric methods compared to parametric methods, and perform non-parametric tests such as the sign test and Mann-Whitney U test.	Analyzing	Conceptual Knowledge	Exams, Case Studies
CO4	Utilize JASP software to conduct various statistical tests including one-sample z-tests, t-tests, and independent samples t-tests.	Applying	Procedural Knowledge	Projects, Practical Work
CO5	Evaluate the relationships between variables using correlation and scatter plots in JASP, interpreting the significance of the results.	Evaluating	Conceptual Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Un it	Content	Hrs (45+ 30)	Marks 70
I	**Sampling methods**		**10**	**15**
	1	Introduction	1	
	2	Types of sampling	1	
	3	Purposive sampling	2	
	4	Random sampling	2	
	5	Simple sampling	2	
	6	Stratified sampling	2	
II	**An introduction to Mediation analysis**		**9**	**15**
	7	The Simple Mediation Model	2	
	8	Estimation of the Direct, Indirect, and Total Effects of X- Brief concept	2	
	9	Concept of confounding and causal order	2	
	10	Conditional and Unconditional Effects	3	
III	**Introduction to Non parametric tests**		**14**	**20**
	11	Non-parametric Methods	2	
	12	Advantages and Disadvantages of Non parametric Methods over parametric methods	2	
	13	Sign test	3	
	14	Median test	2	
	15	Mann Whitney Wilcoxon U test	2	
	16	Wald-Wolfowitz Run Test	3	
IV	**Correlation and test in JASP software**		**12**	**20**
	17	The one-sample z-test .	2	
	18	The one-sample t-test .	2	
	19	The independent samples t-test	3	
	20	The paired-samples t-test	2	
	21	Correlations	2	
	22	Scatter plots	1	
V	**JASP Practice Problems: Normality Testing, Hypothesis Testing, and Decision Making**		**30**	
	Do practice problems using JASP software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Checking the normality of a sample		
	2	Testing non normal data with Wilcoxon tests		
	3	Reporting the results of a hypothesis test		
	4	Making decisions		
	5	p value of a test		

	6	Running hypothesis test in practice		
	7	Discussion on various examples of population		
	8	Discussion on simple random sampling		

Books and References:

1. S.P Gupta (2021),Statistical Methods 46 th Edition
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Hayes, A.F. (2017) Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. Guilford Press, New York
4. Navarro, D.J., Foxcroft, D.R., & Faulkenberry, T.J. (2019). Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners. (Version

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4			3				
CO5			3				

Programme	BSc Statistics				
Course Code	STA1MN107				
Course Title	Basic statistics				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of data, variables, charts and graphs. Basic computer skills				
Course Summary	To provide students with a fundamental understanding of life science data and statistical methods for its analysis.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the concepts of data collection, differentiating between primary and secondary data, population and sample, as well as the advantages and limitations of sampling.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Apply various sampling methods, including simple random sampling, stratified random sampling, and systematic random sampling, to real-life scenarios.	Applying	Conceptual Knowledge	Projects, Practical Work
CO3	Analyze frequency distributions and cumulative frequency distributions, and create appropriate diagrammatic and graphical representations of data.	Analyzing	Conceptual Knowledge	Exams, Case Studies
CO4	Calculate measures of central tendency (mean, median, mode) and measures of dispersion (range, quartile deviation, standard deviation) for a given dataset.	Applying	Procedural Knowledge	Projects, Practical Work
CO5	Explain the concepts of probability, random experiments, and apply the addition and multiplication theorems of probability to solve problems.	Understanding	Factual Knowledge	Exams, Assignments

Detailed Syllabus:

Module	Unit	Content	Hrs(45 +30)	Marks (70)
1	**Collection of Data and Sampling**		**10**	20
	1	Examples of Life Science data	1	
	2	Collection of data- Primary and secondary data,	1	
	3	Population and Sample, Census and Sampling	1	
	4	Advantages and Limitations of Sampling.	1	
	5	Simple Random Sampling (Concept and Method of Selection)	2	
	6	Stratified Random Sampling	2	
	7	Systematic Random Sampling	1	
	8	Sampling and Non-Sampling Errors	1	
2	**Frequency Distribution and Descriptive Statistics**		12	10
	9	Frequency Distribution	2	
	10	Cumulative Frequency distribution	2	
	11	Diagrammatic Representations	4	
	12	Graphical Representation of data	4	
3	**Measures of Central Tendency&Dispersion**		12	20
	13	Measures of Central Tendency	1	
	14	Arithmetic Mean	2	
	15	Median	2	
	16	Mode	2	
	17	Measures of Dispersion	1	
	18	Range, Quartile Deviation	2	
	19	Standard Deviation	2	
4	**Theory of Probability**		11	20
	20	Random Experiment, Sample Space, Events (Basic terminology), Three Conceptual Approaches to Probability, Calculation of Probabilities	4	
	21	Addition theorem (for two and three events) and simple problems (Statement Only)	3	
	22	Conditional Probability & Multiplication theorem of probability (Concept and Problems)	4	
5	**Spreadsheet Practice: Data Organization, Visualizations, and Statistical Measures**		**30**	
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Introduction to spreadsheet		
	2	Frequency distributions for organizing and summarizing data		
	3	Histograms, Bar chart, Pie chart		
	4	Measures of central tendency		
	5	Relative and absolute measures of dispersion		

Books and References:

1. Myra L. Samuels, Jeffrey A. Witmer, Andrew A. Schaffner, Statistics for the Life Sciences, fifth edition (2016), Pearson Education
2. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House
3. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
4. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th edition, Sulthan Chand, New Delhi
5. Mario F Triola, Elementary Statistics using Excel

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4			3				
CO5			3				

Programme	BSc Statistics				
Course Code	STA2MN107				
Course Title	Statistical Inference I				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Understanding of fundamental statistical concepts. Basic knowledge in probability theory and random Variables.				
Course Summary	To equip students with a comprehensive understanding of theoretical distributions, sampling distributions, hypothesis testing, and comparisons between independent and paired samples.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the characteristics and applications of binomial, Poisson, and normal distributions.	Understanding	Factual Knowledge	Exams, Assignments
CO2	Apply the principles of hypothesis testing, including formulating null and alternative hypotheses, types of errors, and the concept of significance.	Applying	Conceptual Knowledge	Projects, Practical Work
CO3	Analyze test statistics for single proportions and differences of proportions in large samples, including the interpretation of p-values.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Apply chi-square tests for goodness of fit and independence of attributes.	Applying	Procedural Knowledge	Projects, Practical Work
CO5	Conduct small sample tests using Student's t-distribution, including tests for single means, differences of means, and paired t-tests.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Theoretical Distributions**		**12**	**15**
	1	Binomial Distribution	3	
	2	Poisson Distribution	3	
	3	Normal Distribution	6	
II		**Testing of Hypothesis**	**13**	**20**
	4	Statistical Hypothesis-Simple and Composite, Null and Alternative	1	
	5	Types of errors in testing, Level of Significance, Critical Region	3	
	6	One tailed and two tailed, p- value	1	
	7	Procedure of testing of hypothesis	1	
	8	Test for Single Proportion-Large Sample	1	
	9	Test of Significance for Difference of Proportions-Large Sample	2	
	10	Test of Significance for a single mean	2	
	11	Test of Significance for difference of Means	2	
III		**Chi- Square Test**	**11**	**20**
	12	Chi-square Distribution	2	
	13	Chi- Square Test of goodness of fit	2	
	14	Chi Square Test for Independence of Attributes	2	
	15	Degrees of Freedom	1	
	16	2 × 2 Contingency table	2	
	17	2 × k Contingency table	2	
IV		**Small sample Tests**	**9**	**15**
	18	Student's t distribution	2	
	19	Applications of t distribution	1	
	20	Test for single mean	2	
	21	t- Test for Difference of Means	2	
	22	Paired t- Test for difference of Means	2	
V	**Spreadsheet Practice: Distribution Analysis and Hypothesis Testing**		**30**	
	Do practice problems using spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Draw histogram and check normality of a given data		
	2	Compute pmf and cdf of Binomial distribution.		
	3	Compute pmf and cdf of Poisson distribution.		
	4	Compute pdf and cdf of Normal distribution.		

	5	Perform t tests.		
	6	Perform Chi square tests.		

Books and References:

1. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House
2. Myra L. Samuels, Jeffrey A. Witmer, Andrew A. Schaffner, Statistics for the Life Sciences fifth edition (2016), Pearson Education
3. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12^{th} edition, Sulthan Chand, New Delhi
4. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
5. Mario F Triola, Elementary Statistics using Excel

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5			3				

Programme	BSc Statistics				
Course Code	STA3MN207				
Course Title	Statistical inference II				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Strong foundation in sampling distributions. Familiarity with simple hypothesis tests.				
Course Summary	This course covers inferential statistics, non-parametric tests, correlation analysis, and regression analysis. Students learn to analyze data using techniques such as ANOVA, Mann-Whitney Test, correlation coefficients, and regression models, enabling them to draw meaningful insights and make informed decisions from statistical data				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the principles and applications of ANOVA, including the F-statistic, one-way, and two-way analysis of variance.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply non-parametric tests, such as the Sign Test, Wilcoxon Signed Rank Test, Mann-Whitney Test, and Kruskal-Wallis Test, to real-world data.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze the correlation between variables using different methods, including the calculation of Karl Pearson's coefficient of correlation.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate linear and non-linear regression models, including the interpretation of regression coefficients and their properties.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Conduct regression analysis using scatter diagrams and interpret the results to understand the relationship between variables.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**ANOVA**		**10**	**20**
	1	F Statistic	2	
	2	F Test for Equality of Population Variance	2	
	3	ANOVA	2	
	4	One-Way Analysis of Variance	2	
	5	Two -Way Analysis of Variance	2	
II	**Non Parametric Test**		**15**	**15**
	5	Introduction to Non Parametric Methods	1	
	6	Advantages and Limitations	1	
	7	Sign Test- one sample	3	
	8	Wilcoxon Signed Rank Test	2	
	9	Mann- Whitney Test	2	
	10	Kruskal- Wallis Test	2	
	11	Single Sample Run Test	2	
	12	Median Test	2	
III	**Correlation Analysis**		**9**	**15**
	13	Correlation	1	
	14	Types of Correlation	1	
	15	Methods of Studying Correlation	1	
	16	Scatter Diagram Method	2	
	17	Karl Pearson's coefficient of correlation (Concept and Problems)	4	
IV	**Regression Analysis**		**11**	**20**
	18	Introduction to Regression	1	
	19	Linear and Non Linear Regression	1	
	20	Lines of Regression	3	
	21	Coefficients of Regression	3	
	22	Properties of Regression Coefficients	3	
V	**Spreadsheet Practice: Scatterplots, Correlation, and Regression Analysis**		**30**	
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Scatterplot		
	2	Correlation		
	3	Regression		

	4	Linear correlation coefficient r		
	5	Graphing regression line		
	6	Outliers		
	7	Influential points		
	8	Residual plot		

Books and References:

1. Gupta, S. C.. (2015). Fundamentals of Statistics, Himalaya Publishing House
2. Myra L. Samuels, Jeffrey A. Witmer, Andrew A. Schaffner, Statistics for the Life Sciences ,fifth edition (2016),Pearson Education
3. Prem S. Mann (2016), Introductory Statistics 9 th Edition, Wiley
4. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics, 11th edition, Sulthan Chand, New Delhi
5. Mario F Triola, Elementary Statistics using Excel

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5			3				

Programme	BSc Statistics				
Course Code	STA1MN108				
Course Title	Statistics for critical thinking I				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic mathematical knowledge				
Course Summary	This course aims to illustrate the relevance of statistics in social studies by delving into the concept of data, its various forms, generation methods, diverse techniques for summarization and visualization, ultimately fostering a comprehensive understanding.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the fundamental concepts of qualitative and quantitative data, types of variables, and relationships between them.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply appropriate sampling methods (simple, stratified, cluster, multistage) in designing observational studies and experiments.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze and summarize numerical data using various techniques, including scatterplots, histograms, and measures of dispersion.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate categorical data using contingency tables and bar plots, and interpret the results for better data understanding.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Construct and interpret box plots and other graphical representations to compare numerical data across different groups.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Unit	Content	Hrs(45 +30)	Marks (70)
I	**Data basics**		**10**	**15**
	1	Qualitative and Quantitative data, variables, and data matrices.	2	
	2	Types of variables, Relationships between variables.	2	
	3	Explanatory and response variables.	2	
	4	Introducing observational studies and experiments.	4	
		Sections from References: Unit 1-4: 1.2 [Ref 2]		
II		**Sampling principles and strategies**	**11**	**15**
	5	Populations and samples, anecdotal evidence.	2	
	6	Sampling from a population, Observational studies. confounding variable, Retrospective studies.	2	
	7	Four sampling methods: simple, stratified, cluster, and multistage sampling.	2	
	8	Experiments: randomized experiment, Principles of experimental design.	3	
	9	Reducing bias in human experiments, treatment group, control group.	2	
III		**Summarizing data**	**15**	**25**
	10	Examining numerical data, Scatterplots for paired data.	1	
	11	Dot plots, the mean and the weighted mean.	2	
	12	Histograms, shape, symmetry, and mode of a data set.	2	
	13	Dispersion: Range, Variance, standard deviation, and coefficient of variation.	2	
	14	Box plots, quartiles, and the median.	2	
	15	Outliers, Inter quantile rage, Quantile deviation.	2	
	16	Robust statistics.	1	
	17	Transforming data.	1	
	18	Mapping data.	2	
IV		**Categorical data**	**9**	**15**
	19	Contingency tables and bar plots.	2	
	20	Row and column proportions, pie chart.	2	
	21	Using a bar plot with two variables, stacked bar plot, side-by-side bar plot, Mosaic plots.	3	
	22	Comparing numerical data across groups: side-by-side box plots and hollow histograms.	2	
V	**Exploratory Data Analysis and Descriptive Statistics using R**		30	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Basic Mathematical Operations and R		

		Preliminaries		
	2	Methods of Data Input		
	3	Graphical Representations (R Code)		
	4	Diagrammatic Representations (R Code)		
	5	Descriptive Measures -Mean		
	6	Median and Mode		
	7	Range		
	8	Standard deviation, variance		

Books and references:

1. Moore, D. S. (2009). *Introduction to the Practice of Statistics*. WH Freeman and company.
2. Diez, D. M., Barr, C. D., & Cetinkaya-Rundel, M. (2019). *OpenIntro statistics*. Boston, MA, USA:: OpenIntro. (Available Online)
3. Asthana, H. S., & Bhushan, B. (2016). *Statistics for social sciences (with SPSS applications)*. PHI Learning Pvt. Ltd..
4. Aron, A., Coups, E. J., & Aron, E. N. (2013). *Statistics for the behavioral and social sciences: A brief course: Pearson new international edition*. Pearson Higher Ed.
5. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh ,Statistics Using R(2015)
6. Sirkin, R. M. (2006). *Statistics for the social sciences*. Sage.
7. Mukherjee, S. P., Sinha, B. K., & Chattopadhyay, A. K. (2018). *Statistical methods in social science research* (pp. 29-37). Springer Singapore.
8. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5			3				

Programme	BSc Statistics				
Course Code	STA2MN108				
Course Title	Statistics for critical thinking II				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic mathematical knowledge, familiarity with functions, graphs and basic equations.				
Course Summary	This course explores different ways to collect data, builds a foundation on probability, describes how to model a random experiment effectively using random variable and discusses some special distributions.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe various data collection methods, including case studies, observations, and surveys, and evaluate the reliability and validity of questionnaires.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply probability concepts, including disjoint outcomes, conditional probability, and Bayes' Theorem, to solve real-world problems.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze and interpret probabilities using contingency tables, joint and marginal probabilities, and tree diagrams.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate the properties of random variables, including expectation and variability, in both discrete and continuous distributions.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Apply knowledge of various discrete distributions (Bernoulli, binomial, Poisson) and their properties to analyze data sets.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module		Content	Hours (45+30)	Marks (70)
I		**Methods of Data Collection**	**9**	**10**
	1	Case study, Observation, Interview, Survey, Use of Secondary Data	3	
	2	Questionnaires and Schedules: Reliability and Validity of Questionnaire	3	
	3	Cleaning Data, Methods to Check reliability of Data.	3	
II		**Probability**	**11**	**20**
	4	Defining probability, Disjoint or mutually exclusive outcomes, Probabilities when events are not disjoint, Venn-diagrams.	2	
	5	Probability distributions, Complement of an event, Independence.	2	
	6	Exploring probabilities with a contingency table, Marginal and joint probabilities.	1	
	7	Defining conditional probability, General multiplication rule.	2	
	8	Sum of conditional Probabilities, Independence considerations in conditional probability, Tree diagrams.	2	
	9	Bayes' Theorem and its applications.	2	
III		**Continuous distributions**	**14**	**20**
	10	Sampling from a small population, without replacement, with replacement.	1	
	11	Random variable and its Expectation.	2	
	12	Variability in random variables.	2	
	13	Linear combinations of random variables, its Expectation and Variability in linear combinations of random variables.	2	
	14	Continuous distributions, From histograms to continuous distributions.	1	
	15	Probabilities from continuous distributions.	2	
	16	Normal distribution, standard normal distribution.	2	
	17	Standardizing with Z-scores, Finding tail areas, examples.	2	
IV		**Discrete distributions**	**11**	**20**
	18	Bernoulli distribution, binomial distribution,	2	
	19	Normal approximation to the binomial distribution,	1	
	20	Poisson distribution.	3	
	21	Geometric distribution.	2	
	22	Negative binomial distribution, Binomial vs Negative binomial distribution.	3	
V		**Exploring and Fitting Probability Distributions in R**	**30**	
		Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.		

	1	Obtain the probability distribution		
	2	Plot the probability distribution		
	3	Obtain the cumulative distribution function		
	4	Plot the cumulative distribution function		
	5	Calculation of distribution Probabilities from binomial		
	6	Calculation of distribution Probabilities from binomial		
	7	Calculation of distribution Probabilities from binomial		
	8	Fitting of Binomial distribution		

Books and References:

1. Asthana, H. S., & Bhushan, B. (2016). *Statistics for social sciences (with SPSS applications)*. PHI Learning Pvt. Ltd..
2. Diez, D. M., Barr, C. D., & Cetinkaya-Rundel, M. (2019). *OpenIntro statistics*. Boston, MA, USA:: OpenIntro.
3. Aron, A., Coups, E. J., & Aron, E. N. (2013). *Statistics for the behavioral and social sciences: A brief course: Pearson new international edition*. Pearson Higher Ed.
4. Sirkin, R. M. (2006). *Statistics for the social sciences*. Sage.
5. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh,Statistics Using R(2015)
6. Mukherjee, S. P., Sinha, B. K., & Chattopadhyay, A. K. (2018). *Statistical methods in social science research* (pp. 29-37). Springer Singapore.
7. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi.
8. Gupta, S. C. and Kapoor, V. K. (2007). Fundamentals of applied Statistics, Sultan Chand and Sons.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA3MN208				
Course Title	Statistics for critical thinking III				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic understanding of introductory statistical concepts. Familiaritywith the fundamentals of probability.				
Course Summary	This course examines different ways to analyse data to make meaningful conclusions about the larger population from it is drawn. Course also explores ways to describe relationships between different variables in a data matrix.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of point estimates, sampling distributions, and the Central Limit Theorem, and their implications in statistical inference.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Construct and interpret confidence intervals for proportions, and apply hypothesis testing for categorical data using p-values and Type I/II errors.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze and interpret results from hypothesis tests for the difference of two proportions and perform chi-square tests for goodness of fit and independence.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate the results of small sample tests, including one-sample and paired t-tests, and apply ANOVA for comparing means among multiple groups.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Apply linear regression techniques to fit models, interpret parameter estimates, and assess model fit using R2R^2R2.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks 70
I		**Statistical Inference**	**12**	**17**
	1	Point estimates and sampling variability, Sampling error, Bias.	1	
	2	Sampling distribution, standard error, Central Limit Theorem.	1	
	3	Applying the Central Limit Theorem to a real-world setting, More details regarding the Central Limit Theorem.	2	
	4	Confidence intervals for a proportion, Capturing the population parameter.	2	
	5	Constructing a 95% confidence interval	1	
	6	Changing the confidence level, margin of error, case studies, Interpreting confidence intervals.	1	
	7	Hypothesis testing for a proportion, null hypothesis and alternative hypothesis, Type I and Type II errors, Formal testing using p-values.	4	
II		**Hypothesis testing**	**12**	**17**
	8	Inference for categorical data, Inference for a single proportion, Confidence intervals for a proportion.	2	
	9	Hypothesis testing for a proportion, Choosing a sample size when estimating a proportion.	1	
	10	Difference of two proportions, Sampling distribution of the difference of two proportions.	2	
	11	Hypothesis tests for the difference of two proportions.	1	
	12	Testing for goodness of fit using chi-square: Creating a test statistic for one-way tables, The chi-square test statistic.	2	
	13	The chi-square distribution and finding areas,	2	
		Finding a p-value for a chi-square distribution, Evaluating goodness of fit for a distribution.		
	14	Testing for independence in two-way tables, The chi-square test for two-way tables.	2	
III		**Small sample tests**	**14**	**19**
	15	Inference for numerical data: One-sample means with the t-distribution, The sampling distribution of sample mean, Introducing the t-distribution, One sample t-tests.	3	
	16	Paired data, paired t-test. Difference of two means,	2	
	17	Hypothesis tests for the difference of two means, Confidence interval for a difference of means	4	
	18	Comparing many means with ANOVA: Core ideas of ANOVA, Analysis of variance (ANOVA) and the F -test.	3	
	19	Reading an ANOVA table from software, Multiple comparisons and controlling Type 1 Error rate.	2	

IV		**Regression**	**7**	**17**
	20	Introduction to linear regression: Fitting a line, residuals, and correlation, Describing linear relationships with correlation.	3	
	21	Least squares regression, Conditions for the least squares line, Finding the least squares line.	2	
	22	Interpreting regression model parameter estimates, Using R2 to describe the strength of a fit, Categorical predictors with two levels.	2	
V	**Practice Problems in R Software: Statistical Tests and Analyses**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Test Concerning Means-One sample		
	2	Analytical Methods of checking assumption of normality of parent population		
	3	Test of Significance for difference of two population means		
	4	Test of Significance for difference of two population proportions		
	5	ANOVA		
	6	Correlation		
	7	Inference procedures for correlation coefficient		
	8	Linear regression		

Books and References:

1. Asthana, H. S., & Bhushan, B. (2016). *Statistics for social sciences (with SPSS applications)*. PHI Learning Pvt. Ltd..
2. Diez, D. M., Barr, C. D., & Cetinkaya-Rundel, M. (2019). *OpenIntro statistics*. Boston, MA, USA:: OpenIntro.
3. Aron, A., Coups, E. J., & Aron, E. N. (2013). *Statistics for the behavioral and social sciences: A brief course: Pearson new international edition*. Pearson Higher Ed.
4. Sirkin, R. M. (2006). *Statistics for the social sciences*. Sage.
5. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh ,Statistics Using R(2015).
6. Mukherjee, S. P., Sinha, B. K., & Chattopadhyay, A. K. (2018). *Statistical methods in social science research* (pp. 29-37). Springer Singapore.
7. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA1MN109				
Course Title	Elementary statistics				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of mathematics, including algebra and calculus. Familiarity with geographical concepts and spatial data.				
Course Summary	To equip students with the fundamental principles of statistical analysis and their application in geographical contexts, enabling them to effectively analyze, interpret, and communicate spatial data.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the relationship between statistical analysis and geography, including the importance of different types of data sources.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Organize, classify, and display data effectively using frequency distributions and tabulation, while adhering to the requisites of good tables.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze and interpret various types of diagrams and graphs, understanding their limitations in representing data.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate measures of central tendency and dispersion, selecting appropriate averages for different data sets and understanding their limitations.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Apply correlation and regression techniques to analyze relationships between variables and construct lines of regression.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Unit	Content	Hours (45 +30)	Marks (70)
I		**STATISTICS AND GEOGRAPHY**	**10**	**15**
	1	Statistical Analysis and Geography	1	
	2	Data, sources of data, internal data, external data, primary and secondary data, meta data	2	
	3	Data collection, characteristics of data sets	2	
	4	Quantitative and qualitative data sets	1	
	5	Measurement Evaluation: Precision, Validity, accuracy	2	
	6	Data and Information	1	
II		**DISPLAYING AND INTERPRETING DATA**	**12**	**15**
	7	Organization of data	2	
	8	Classification	2	
	9	Frequency distribution	2	
	10	Basic principles for forming a groupes frequency distribution	2	
	11	Cumulative and bivariate frequency distribution	2	
	12	Tabulation, requisites of a good table	2	
III		**REPRESENTATIONS OF DATA**	**14**	**25**
	13	Types of diagrams	1	
	14	Graphical representation of data	3	
	15	Limitations of diagrams and graphs	1	
	16	Measures of Central Tendency:	4	
	17	Selection and limitations of an average	2	
	18	Measures of Dispersion	3	
IV		**CORRELATION AND REGRESSION**	**10**	**15**
	19	Correlation	2	
	20	Correlation coefficient	2	
	21	Regression	3	
	22	Lines of regression	3	
5		**Practice Problems in Spreadsheet: Data Analysis and Visualization Techniques**	**30**	
		Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.		
	1	Types of data		
	2	Introduction to spreadsheet		
	3	Frequency distributions for organizing and summarizing data		
	4	Histograms		
	5	Graphs that enlighten and graphs that deceive		
	6	Measures of central tendency		
	7	Measures of dispersion		

	8	Measures of Relative Standing and Boxplots		

Books and References:

1. James E. Burt_ Gerald M. Barber_ David L. Rigby - Elementary Statistics for Geographers-The Guilford Press (2009)
2. Gupta, S. C.. (2015). Fundamentals of Statistics, Himalaya Publishing House.
3. J. Chapman McGrew Jr., Arthur J. Lembo Jr., Charles B. Monroe - An Introduction to Statistical Problem Solving in Geography, Third Edition-Waveland Press, Inc. (2014)
4. Mario F Triola, Elementary Statistics using Excel.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA2MN109				
Course Title	Theory of probability				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Knowledge of introductory statistics would be beneficial for students				
	to grasp the content covered in the course effectively.				
Course Summary	Provide students with a foundational understanding of probability theory and its applications in statistical experiments, random variables, probability distributions, and sampling techniques.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe fundamental concepts of probability, including set theory, permutations, combinations, and the definitions of probability.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply the addition and multiplication theorems of probability to solve problems involving independent events and their relationships.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze random variables and their probability distributions, including discrete and continuous random variables.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate the importance of standard distributions (Binomial, Poisson, Normal) and their applications in statistical analysis.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Implement various sampling techniques, including purposive, simple random, stratified, and systematic sampling in survey research.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Units	Content	Hrs(45 +30)	Marks (70)
I	**PROBABILITY**		**12**	**20**
	1	Mathematical Preliminaries	1	
	2	Set theory	2	
	3	Permutation and combination	1	
	4	Definitions of probability	1	
	5	Addition theorem of probability	2	
	6	Multiplication theorem of probability	2	
	7	Independent events, multiplication theorem for independent events	2	
	8	Pairwise and mutual independence	1	
II	**RANDOM VARIABLES**		**10**	**15**
	9	Random variable, probability distribution of discrete and continuous random variable	2	
	10	Distribution function	2	
	11	Moments (definition only)	2	
	12	Mathematical Expectation	2	
	13	Variance and covariance	2	
III	**STANDARD DISTRIBUTIONS**		**12**	**20**
	14	Binomial distribution	2	
	15	Poisson distribution	2	
	16	Normal distribution	4	
	17	Areas under standard normal probability curve, Importance of normal distribution	4	
IV	**SAMPLING**		**11**	**15**
	18	Census, sample, principal steps in sample survey	2	
	19	Purposive Sampling	2	
	20	Simple random Sampling	3	
	21	Stratified random sampling	2	
	22	Systematic Sampling	2	
V	**Practice Problems on Probability Distributions and Statistical Calculations in Spreadsheets**		**30**	
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Probability distribution		
	2	Probability histogram		
	3	Mean and variance of probability distribution		
	4	Finding binomial probabilities		
	5	Finding Poisson probabilities		
	6	Finding normal probabilities		
	7	Finding z scores from known areas		
	8	Find critical values		

Books and References:

1. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House.
2. James E. BurtGerald M. Barber David L. Rigby - Elementary Statistics for Geographers-The Guilford Press (2009)
3. J. Chapman McGrew Jr., Arthur J. Lembo Jr., Charles B. Monroe - An Introduction to Statistical Problem Solving in Geography, Third Edition-Waveland Press, Inc. (2014)
4. Mario F Triola, Elementary Statistics using Excel.

Mapping of COs with PSOs and POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA3MN209				
Course Title	Statistical inference				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of random variable, probability, standard distributions				
Course Summary	Equip students with a comprehensive understanding of sampling theory and its applications in statistical inference.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts of parameters and statistics, sampling distributions, and the principles of sampling.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply the Central Limit Theorem to determine the sampling distribution of a statistic for various sample sizes.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze point estimation and interval estimation procedures, including the characteristics of unbiased and efficient estimators.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate hypotheses using statistical testing methods, including understanding types of errors, critical regions, and p-values.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Perform Chi-square tests for goodness of fit and independence of attributes, interpreting the results in terms of degrees of freedom.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Units	Content	Hrs(45 +30)	Marks (70)
I	**SAMPLING THEORY**		**10**	**10**
	1	Parameter and statistic	2	
	2	Sampling Distribution	2	
	3	Principles of sampling	2	
	4	Sampling distribution of a statistic	2	
	5	Central limit theorem	2	
II	**THEORY OF ESTIMATION**		**11**	**25**
	6	Statistical Estimation Procedures-Point Estimation and Interval estimation	2	
	7	Point estimation- Estimator and Estimate (Definition, Concept), Unbiases Estimator and Efficient Estimator, Point Estimators of Population Mean, Population Proportion, Population Variance	3	
	8	Interval estimation-Definition	3	
	9	Size of the random sample for specified precision	3	
III	**HYPOTHESIS TESTING**		**12**	**20**
	10	Testing of hypothesis, simple and composite hypothesis, null and alternate hypothesis	2	
	11	Types of errors, Size and power of tests, critical region	2	
	12	One tailed and two tailed tests	1	
	13	P- value or probability value of test statistic	1	
	14	Large sample tests	2	
	15	Test for single proportion	2	
	16	Test for single mean	2	
IV	**CHI SQUARE TEST**		**12**	**15**
	17	Probability density function of distribution Chi- square	1	
	18	Applications of Chi square distribution	2	
	19	Chi square test of goodness of fit	3	
	20	Conditions for the validity for Chi square test	2	
	21	Chi square test for independence of attributes	3	
	22	Degrees of freedom	1	
V	**Practice Problems on Confidence Intervals and Hypothesis Testing in Spreadsheets**		**30**	
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course.			
	1	Confidence interval for mean of single population		

	2	Confidence interval for difference of mean of double population		
	3	Confidence interval for proportion of single population		
	4	Confidence interval for difference of proportion of double population		
	5	Testing of hypothesis for mean of large population		
	6	Testing of hypothesis for mean of small population		
	7	Chi square test of goodness of fit		
	8	Chi square test for independence of attributes		

Books and References:

1. Gupta, S. C.. (2015). Fundamentals of Statistics, Himalaya Publishing House.
2. James E. Burt_ Gerald M. Barber_ David L. Rigby - Elementary Statistics for Geographers-The Guilford Press (2009)
3. J. Chapman McGrew Jr., Arthur J. Lembo Jr., Charles B. Monroe - An Introduction to Statistical Problem Solving in Geography, Third Edition-Waveland Press, Inc. (2014)
4. Mario F Triola, Elementary Statistics using Excel.

Mapping of COs with PSOs and POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA1MN110				
Course Title	Basic statistics and data visualization				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic mathematical knowledge, skills in logical thinking and problem solving				
Course Summary	Through theoretical concepts and practical applications, students will develop the skills necessary to classify data, organize frequency distributions, and calculate and interpret measures of central tendency and dispersion.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Describe the types of data (primary, secondary, quantitative, qualitative, discrete, continuous) and their characteristics.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Construct frequency distributions, histograms, frequency polygons, frequency curves, and ogives for various data types.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze measures of central tendency and their applicability to different data sets.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate various measures of dispersion to assess data variability.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Apply statistical quality control concepts by constructing control charts and interpreting their results.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Introduction of data**		**9**	**15**
	1	Types of data- Primary data, Secondary data, Quantitative data, Qualitative data, Discrete data, Continuous data	2	
	2	Frequency distributions for discrete and continuous variables- Cumulative frequency distribution	2	
	3	Histogram, Frequency Polygon	3	
	4	Frequency Curve, Ogives	2	
II	**Measures of central tendency**		**9**	**15**
	5	Mean	2	
	6	Median, Mode	3	
	7	GM	2	
	8	HM	2	
III	**Measures of dispersion**		**19**	**25**
	9	Positional values – Quartiles	2	
	10	Deciles	2	
	11	Percentiles	1	
	12	Range	1	
	13	Quartile deviation	3	
	14	Mean deviation	3	
	15	Standard deviation	3	
	16	Coefficient of variation	1	
	17	Coefficient of dispersion	3	
IV	**Statistical Quality Control**		**8**	**15**
	18	Concept of statistical quality control, assignable causes and chance causes, process control.	2	
	19	Construction of control charts, 3sigma limits	2	
	20	Control chart for variables: Mean chart and Range chart	2	
	21	Control chart for attributes: c chart	1	
	22	np chart	1	
V	**Practice Problems on Data Analysis and Descriptive Statistics in Spreadsheet**			
	Do practice problems in spreadsheet from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course. Types of data Frequency distributions for organizing and summarizing data Graphs of frequency distribution Arithmetic mean Median and Mode Partition of values control Measure of dispersion Different charts in quality			

Books and References:

1. Gupta,S.C. and Kapoor,V.K.(2002).Fundamentals of Mathematical Statistics. , 11th edition, Sulthan Chand, New Delhi.
2. Gupta, P.K. and Man Mohan. (1987). Operations Research and Statistical Analysis, Third edition, Sultan Chand, New Delhi.
3. Gupta, S. C.(2015). Fundamentals of Statistics, Himalaya Publishing House.
4. Mario F Triola, Elementary Statistics using Excel, (2018), 6th edition.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA2MN110				
Course Title	Data analysis foundations in statistics				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic mathematical skills				
Course Summary	Equip students with the theoretical foundation and practical skills necessary to analyze and interpret time-series data.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the components of time series and differentiate between additive and multiplicative models.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply various methods to measure trends in time series data using graphic methods, semi-average methods, moving averages, and least squares.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze and construct index numbers, including simple and weighted index numbers, and evaluate their effectiveness.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate correlation and regression concepts by constructing scatter diagrams and calculating Pearson's and Spearman's correlation coefficients.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Utilize R programming for basic mathematical operations, data input methods, and graphical representations to perform descriptive statistics.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs(45 +30)	Marks (70)
I	**Time series analysis**		**9**	**15**
	1	Time series analysis: Components of time series, additive and multiplicative models	1	
	2	measurement of trend- Graphic method, Semi-average method	3	
	3	Method of moving averages	3	
	4	Method of least squares- Straight line trend	2	
II	**Index numbers**		**10**	**15**
	5	meaning and definition,uses and types, problems in the construction of index numbers	3	
	6	different types of simple index numbers	3	
	7	different types of weighted index numbers	2	
	8	Test for an ideal index number, time and factor reversal test	2	
III	**Correlation and Regression**		**18**	**25**
	9	Scatter diagram	2	
	10	Correlation	2	
	11	Types of correlation	1	
	12	Pearson's coefficient of correlation	3	
	13	Spearman's rank correlation	3	
	14	Spearman's rank correlation with repeated ranks	3	
	15	Regression	1	
	16	Linear regression	1	
	17	Properties of regression lines	2	
IV	**Introduction to R programming**		**8**	**15**
	18	Installation & Basic Mathematical Operations	2	
	19	R Preliminaries, Methods of Data Input	2	
	20	Graphical Representations (R Code)	2	
	21	Diagrammatic Representations (R Code)	1	
	22	Descriptive Measures (Mean, Median, Mode)	1	
V	**R Practice: Mathematical Operations, Distributions, and Measures of Central Tendency**		**30**	
	Do practice problems in R Software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course. 1. Basic mathematical operations 2. Frequency distributions for organizing and summarizing data 3. Histogram 4. Frequency curve 5. Pie diagram 6. Arithmetic mean 7. Median 8. Mode			

Books and References:

1. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House
2. Gupta, S.C. and Kapoor,V.K. (2002). Fundamentals of Mathematical Statistics**,** 11th edition, Sulthan Chand, New Delhi.
3. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA3MN210				
Course Title	Probability theory and sampling techniques				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Understanding of basic algebraic operations and set theory. Familiarity with functions, graphs and their properties.				
Course Summary	Through theoretical concepts and practical applications, students will develop the skills necessary to analyze uncertainty, conduct sample surveys, and implement statistical quality control methods.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the fundamental concepts of probability, including classical and axiomatic definitions.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply the addition and multiplication theorems to solve problems involving conditional probability and independence of events.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze random variables and their probability distributions, including mathematical expectation and variance for discrete cases.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate sampling methods by identifying the advantages and limitations of different sampling techniques and recognizing sampling errors.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Utilize R programming for statistical calculations such as range, variance, and Pearson’s correlation, while implementing loops and conditional statements.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs(45+30)	Marks (70)
I	**Probability**		**10**	**15**
	1	Basic concepts of Probability, Classical definition of Probability, Axiomatic approach to Probability	2	
	2	Addition Theorem, Multiplication Theorem	3	
	3	Conditional Probability	3	
	4	Independence of events	2	
II	**Random Variables**		**8**	**15**
	5	Random Variables, Discrete and continuous random variables	2	
	6	Probability distribution, Distribution function (Applications in discrete case)	2	
	7	Mathematical expectation (Applications in discrete case)	2	
	8	Variance (Applications in discrete case)	2	
III	**Sampling theory**		**19**	**25**
	9	Population and Sample	2	
	10	Census and Sampling Method	3	
	11	Advantages and Limitations of Sampling	1	
	12	principal steps in sample survey	3	
	13	Sampling Errors	3	
	14	Non-Sampling Errors	3	
	15	Simple random sampling (Concept and Methods of selection)	1	
	16	Stratified random sampling	1	
	17	Systematic Sampling	2	
IV	**R programming**		**8**	**15**
	18	Range	2	
	19	Variance	2	
	20	Loops- Brief explanation	2	
	21	Pearson's correlation	1	
	22	Conditional statements (Brief)	1	
V	**R Practice: Measures of Dispersion, Covariance, and Correlation**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course. 1. Range 2. Mean Deviation 3. Quartile Deviation 4. Standard Deviation			

	5. Variance 6. Covariance 7. Correlation 8. Rank correlation		

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th edition, Sulthan Chand, New Delhi
2. Douglas, Alex, Deon Roos, Francesca Mancini, Ana Couto, and David Lusseau. (2020), *An Introduction to R*. https://intro2r.com/index.html**.**
3. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA1MN111				
Course Title	Fundamentals of data analysis				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Competence in basic algebraic concepts, knowledge of basic data visualization techniques.				
Course Summary	Provide students with a comprehensive understanding of different types of data, methods of data collection, frequency distributions, graphical representation techniques, measures of central tendency and dispersion, positional values, and utilization of statistical tools like R for data analysis.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Classify different types of data, including primary, secondary, quantitative, and qualitative data.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply concepts of frequency distribution to create histograms, frequency polygons, and cumulative frequency distributions for discrete and continuous data.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze measures of central tendency, including mean, median, mode, geometric mean, and harmonic mean, to summarize data sets.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate measures of dispersion such as quartiles, deciles, percentiles, range, standard deviation, and coefficient of variation to assess data variability.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Utilize R programming to perform basic mathematical operations, data input methods, and graphical representations of descriptive measures.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Introduction of data**		**9**	**15**
	1	Types of data- Primary data, Secondary data, Quantitative data, Qualitative data, Discrete data, Continuous data	2	
	2	Frequency distributions for discrete and continuous variables- Cumulative frequency distribution	2	
	3	Histogram, Frequency Polygon	3	
	4	Frequency Curve, Ogives	2	
II	**Measures of central tendency**		**9**	**15**
	5	Mean	2	
	6	Median, Mode	3	
	7	GM	2	
	8	HM	2	
III	**Measures of dispersion**		**19**	**25**
	9	Positional values – Quartiles	2	
	10	Deciles	3	
	11	Percentiles	1	
	12	Range	1	
	13	Quartile deviation	2	
	14	Mean deviation	3	
	15	Standard deviation	3	
	16	Coefficient of variation	1	
	17	Coefficient of dispersion	3	
IV	**Introduction to R programming**		**8**	**15**
	18	Installation & Basic Mathematical Operations	2	
	19	R Preliminaries, Methods of Data Input	2	
	20	Graphical Representations (R Code)	2	
	21	Diagrammatic Representations (R Code)	1	
	22	Descriptive Measures (Mean, Median, Mode)	1	
V	**R Practice: Basic Statistics and Graphical Representations**		**30**	
	Do practice problems in R Software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course. Basic mathematical operations 1. Frequency distributions for organizing and summarizing data 2. Histogram 3. Frequency curve 5. Pie diagram			

	6. Arithmetic mean 7. Median 8. Mode		

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th edition, Sulthan Chand, New Delhi.
2. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R.
3. Gupta, S. C.(2015). Fundamentals of Statistics, Himalaya Publishing House.

Mapping of COs with PSOs and POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA2MN111				
Course Title	Statistical modeling and sampling techniques				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Knowledge of fundamental statistics including measures of central tendency and dispersion. Basic knowledge of computer.				
Course Summary	Equip students with the theoretical foundation and practical skills necessary for understanding and applying statistical methods related to moments, measures of skewness and kurtosis, fitting different types of curves, analyzing relationships between variables through correlation and regression, understanding sampling techniques, and utilizing R programming for data computation and visualization.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the concepts and measures of skewness and kurtosis.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply sampling theory to determine sample size, recognize sampling errors, and utilize different sampling methods, including simple random and stratified sampling.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze relationships between variables using correlation methods, including Pearson's and Spearman's rank correlation, and fit linear and parabolic regression models.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate the properties of regression lines and the effectiveness of regression models in predicting outcomes.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Utilize R programming to calculate range, interquartile range, standard deviation, and Pearson's correlation, including brief explanations of loops.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Skewness and Kurtosis**		**9**	**15**
	1	Skewness, Kurtosis definitions and different types	2	
	2	Pearson's coefficient of skewness	2	
	3	Bowley's coefficient of skewness	2	
	4	Percentile coefficient of kurtosis	3	
II	**Sampling Theory**		**9**	**15**
	5	Sample size, sampling errors, methods of sampling. Census and Sampling, principal steps in sample survey	2	
	6	organization and execution of large sample surveys, sampling and non-sampling errors	3	
	7	preparation of questionnaire	2	
	8	Simple random sampling, Stratified random sampling, Systematic Sampling	2	
III	**Correlation and Regression**		**19**	**25**
	9	Fitting a straight line	2	
	10	Fitting a Parabola	2	
	11	Scatter diagram	1	
	12	Correlation, Types of correlation	3	
	13	Pearson's coefficient of correlation	3	
	14	Spearman's rank correlation	3	
	15	Regression	1	
	16	Linear regression	1	
	17	Properties of regression lines	3	
IV	**R programming**		**8**	**15**
	18	Range	2	
	19	Inter Quartile Range	2	
	20	Standard Deviation	2	
	21	Pearson's correlation	1	
	22	Loops- Brief explanation	1	
V	**R Practice: Statistical Measures and Correlations**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course. 1. Range 2. Mean Deviation 3. Quartile Deviation 4. Standard Deviation 5. Variance 6. Covariance 7. Correlation 8. Rank correlation			

Books and References:

1. Douglas, Alex, Deon Roos, Francesca Mancini, Ana Couto, and David Lusseau. (2020), *An Introduction to R*. https://intro2r.com/index.html**.**
2. Gupta, S.C. and Kapoor, V.K. (1997) Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
3. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh (2015), Statistics Using R.

Mapping of COs with PSOs and POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA3MN211				
Course Title	Probability theory and statistical distributions				
Type of Course	Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Familiarity with basic calculus such as differentiation and integration, basic knowledge of set theory. Experience with basic data visualization techniques.				
Course Summary	Provide students with a solid foundation in probability theory, including classical and axiomatic approaches, conditional probability, random variables, probability distributions and their applications.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the basic concepts of probability, including classical definitions, axiomatic approaches, and theorems.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply concepts of conditional probability and independence of events to solve related problems.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze discrete and continuous random variables, their probability distributions, and calculate mathematical expectation and variance.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate various probability distributions (Binomial, Poisson, Normal, Uniform, Exponential, Gamma, and Beta) by solving related problems.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Utilize R programming to create statistical tables, compute cumulative distributions, and plot probability density functions for discrete and continuous distributions.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Probability**		**9**	**15**
	1	Basic concepts of Probability, Classical definition of Probability, Axiomatic approach to Probability	2	
	2	Addition Theorem, Multiplication Theorem	3	
	3	Conditional Probability	2	
	4	Independence of events	2	
II	**Random Variables**		**9**	**15**
	5	Random Variables, Discrete and continuous random variables	2	
	6	Probability distribution, Distribution function (Applications in discrete case)	3	
	7	Mathematical expectation Applications in discrete case)	2	
	8	Variance (Applications in discrete case)	2	
III	**Discrete and Continuous distributions**		**19**	**25**
	9	Binomial distribution (Definition and problems)	2	
	10	Poisson distribution (Definition and problems)	2	
	11	Normal distribution (Definition and problems)	1	
	12	Properties of Normal distribution	3	
	13	Uniform distribution (Definition and properties)	3	
	14	Exponential distribution (Definition and properties)	3	
	15	Gamma distribution (Definition and properties)	1	
	16	Beta distribution (Definition and properties)	1	
	17	Cauchy, Pareto distribution (Definition only)	3	
IV	**R programming**		**8**	**15**
	18	R as a set of statistical tables	2	
	19	cumulative distribution	2	
	20	probability density function	2	
	21	plotting probability curves for standard discrete distributions.	1	
	22	plotting probability curves for standard continuous distributions	1	
V	**R Practice: Probability Distributions and Their Graphs**		**30**	
	Do practice problems in R software from any 5 units of the given list and one additional problem decided by the teacher-in-charge, related to the content of the course. Other units listed here may be used as demonstrations of the concepts taught in the course. 1. Graph of Binomial distribution 2. Graph of Poisson distribution 3. Graph of Normal distribution 4. Graph of Uniform distribution 5. Graph of Exponential distribution 6. Graph of Gamma distribution 7. Graph of Beta distribution 8. Graph of Cauchy distribution			

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th edition, Sulthan Chand, New Delhi
2. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House
3. Sudha G Purohith, Sharad D Core, Shailaja R Deshmukh, Statistics Using R(2015)

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

FOUNDATION COURSES IN STATISTICS

SYLLABUS

Programme	B. Sc. Statistics				
Course Code	STA1FM101				
Course Title	Quality Control				
Type of Course	MDC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	HSE level Mathematics Course				
Course Summary	To make students aware of Various Quality or standards in Industrial Production, Detecting, Controlling and Maintaining Quality and Total Quality Management				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define quality and explain various aspects of quality, including causes of variation and statistical measures.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply the concept of statistical quality control, including process control and product control, using appropriate statistical measures.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze quantitative and qualitative variables and assess statistical control using control charts.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Evaluate and construct various types of control charts (mean, range, standard deviation, proportion defective, etc.) for quality control.	Evaluating	Conceptual Knowledge	Projects, Practical Work
CO5	Implement an acceptance sampling plan, including concepts like acceptable quality level, rejectable quality level, and associated risks.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (36+9)	Marks (50)
I	**Understanding Quality and Sources of Variation**		**9**	**15**
	1	Meaning of Quality. Various Aspects of Quality.		
	2	Causes of Variation, assessing within and between sample		
	3	variation using Statistical Measures		
	4	Concept of Statistical Quality Control, Process Control and Product Control		
II	**Quantitative and Qualitative Variables**		**9**	**15**
	5	Variables and Attributes.		
	6	Concept of Control Charts for Process Control		
	7	Structure of a Control Chart		
	8	Assessment of Statistical control using control charts		
III	**Construction of Charts**		**9**	**10**
	9	Construction of (mean) $\bar{x}$ chart		
	10	Construction of R (Range)chart		
	11	Construction of σ (Standard Deviation) chart		
	12	Construction of P (Proportion Defective) chart		
	13	Construction of np (Number of Defectives) chart		
	14	Construction of C (Number of Defects) chart.		
IV	**Sampling Inspection Plan**		**9**	**10**
	15	Acceptance Sampling Plan		
	16	Incoming Quality and Outgoing Quality		
	17	Acceptable Quality Level, Rejectable Quality Level, LTPD		
	18	AOQ, AOQL		
	19	Errors in Sampling Inspection Plan Producers and Consumers Risk		
V	**Exercises on Arithmetic Mean, Range, Standard Deviation, and Basic Probability Concepts in R**		**9**	
	1	Exercises to compute Arithmetic Mean, Range, Standard Deviation for a set of data, Basic concepts of Probability		

Books and References:

1. Introduction to Statistical Quality Control, 8th Edition Douglas C Montgomery
2. Statistical Quality Control M Mahajan Dhanpat Rai 2nd Edition
3. Fundamentals of Applied Statistics, S C Gupta and V K Kapoor Sultan Chand & Sons

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5		3					

Programme	BSc Statistics				
Course Code	STA1FM102				
Course Title	Fundamentals of Statistics				
Type of Course	MDC				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Basic mathematical knowledge				
Course Summary	Students will learn about different types of data, scales of measurement, and techniques for representing and summarizing data using measures of central tendency and dispersion, as well as exploring concepts of skewness and kurtosis.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define statistics and describe its scope, including key concepts of statistical population and sample.	Remembering	Factual Knowledge	Exams, Quizzes
CO2	Explain various types of data, scales of measurement, and classification methods for organizing data.	Understanding	Conceptual Knowledge	Exams, Assignments
CO3	Apply methods for tabulating and graphically representing data, including various diagrammatic techniques.	Applying	Procedural Knowledge	Projects, Practical Work
CO4	Analyze measures of central tendency, including arithmetic, geometric, and harmonic means, along with median and mode.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO5	Evaluate measures of dispersion, skewness, and kurtosis, and interpret their implications for data analysis.	Evaluating	Conceptual Knowledge	Projects, Practical Work

Detailed Syllabus:

Module		Content	Hours (36+9)	Marks (50)
I		**Introduction to Statistics**	**8**	**10**
	1	Definition of Statistics	1	
	2	Scope of Statistics	2	
	3	Concepts of statistical population and sample	2	
	4	Collection of data	3	
II		**Organizing and Graphing Data**	**12**	**15**
	5	Types of data	3	
	6	Scale of measurements	2	
	7	Classification of data	2	
	8	Tabulation of data	2	
	9	Diagrammatic representation of data	3	
III		**Measures of Central Tendency & Dispersion**	**11**	**15**
	10	Arithmetic Mean	2	
	11	Geometric Mean	1	
	12	Harmonic Mean	1	
	13	Median & Mode	2	
	14	Measures of Dispersion - Definition	1	
	15	Absolute Measures of Dispersion	4	
IV		**Skewness & Kurtosis**	**5**	**10**
	16	Partition values	3	
	17	Skewness	1	
	18	Kurtosis	1	
V	**Exercises on Frequency Distributions, Measures of Central Tendency, and Measures of Dispersion**		**9**	
	1	Frequency distributions for organizing and summarizing data	3	
	2	Measures of Central Tendency	3	
	3	Measures of Dispersion	3	
	Books and References: 1. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi. 2. Prem. S. Mann (2010). Introductory Statistics, 7th edition, Wiley Mario F Triola, Elementary Statistics using Excel, (2018), 6th edition.			

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5					3		

Programme	B. Sc. Statistics				
Course Code	STA2FM103				
Course Title	Managerial Decision Making				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	HSE level Mathematics Course				
Course Summary	To make students aware of importance of managerial decisions and the use of Statistical theories in developing scientific decisions				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define key concepts in decision-making, including uncertainty, conflict, decision alternatives, and states of nature.	Remembering	Factual Knowledge	Exams, Quizzes
CO2	Explain the parameters of inventory management and the importance of inventory in business operations.	Understanding	Conceptual Knowledge	Exams, Assignments
CO3	Apply the Economic Order Quantity (EOQ) model to inventory management, both with and without lead time.	Applying	Procedural Knowledge	Projects, Practical Work
CO4	Analyze inventory simulation methods, including the Monte Carlo Method, and their applications in inventory management.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO5	Evaluate game theory concepts, including strategies, payoffs, and the principle of dominance, in solving games.	Evaluating	Conceptual Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (36+9)	Marks (50)
I	**Concepts of Decision Making**		**9**	
	1	Environment Uncertainty and Conflict		
	2	Decision Alternatives		
	3	States of Nature		
	4	Pay Off		
	5	Computation of Expected Monetary Value		

II	**Inventory**		**9**	
	5	Inventory Management.		
	6	Need and necessity of Inventory		
	7	Parameters of Inventory management.		
	8	Economic Order Quantity with and without lead time		
III	**Simulation of Inventory**		**9**	
	9	Simulation		
	10	Monte Carlo Method		
	11	Use of simulation in Inventory		
	12	Game theory		
	13	Strategy, Pay off, Pay off matrix,		
	14	Pure and Mixed strategies, Value of game		
IV	**Solving games**		**9**	
	15	Minmax and Max-min Criterions		
	16	Saddle Point and solution		
	17	Principle of Dominance		
	18	Solving 2x2 games		
	19	Graphical solution of 2xn and nx2 games		
V	**Exercises on Basics of Matrices, Vectors, Probability and Expected Value of Variables**		**9**	
	1	Basics of Matrices, Scalar and Vector multiplication, Concepts of Probability and Expected Value of Variables		

Books and References:

1. Anderson, David R., Dennis J. Sweeney, and Thomas A. Williams. *An Introduction to Management Science: Quantitative Approaches to Decision Making*. 16th ed., Cengage Learning, 2020.
2. Render, Barry, Ralph M. Stair, and Michael E. Hanna. *Quantitative Analysis for Management*. 13th ed., Pearson, 2018.
3. Luce, R. Duncan, and Howard Raiffa. *Games and Decisions: Introduction and Critical Survey*. Dover Publications, 1989.
4. Taha, Hamdy A. *Operations Research: An Introduction*. 10th ed., Pearson, 2017.
5. Hillier, Frederick S., and Gerald J. Lieberman. *Introduction to Operations Research*. 10th ed., McGraw-Hill, 2014.

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5					3		

Programme	BSc Statistics				
Course Code	STA2FM104				
Course Title	Statistical sampling and probability theory				
Type of Course	MDC				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites					
Course Summary	Students will learn a comprehensive understanding of fundamental concepts in statistics, including data, variables, attributes, and methods of data collection and explore various types of sampling methods and understand the basics of probability theory.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Define basic statistical concepts, including data, variables, population, and sample.	Remembering	Factual Knowledge	Exams, Quizzes
CO2	Explain the principles of census and sampling, including the steps involved in a sample survey.	Understanding	Conceptual Knowledge	Exams, Assignments
CO3	Apply different types of sampling methods, including simple random sampling, stratified sampling, and systematic sampling.	Applying	Procedural Knowledge	Projects, Practical Work
CO4	Analyze random sampling methods and understand their application in various statistical studies.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO5	Explain the basic concepts of probability, including random experiments, sample space, and events.	Understanding	Conceptual Knowledge	Exams, Assignments

Detailed Syllabus

Module		Content	Hours (36+9)	Marks (50)
I		**Basic Statistics**	**10**	**10**
	1	Data	2	
	2	Variables and Attributes	2	
	3	Definition of Population and Sample	3	
	4	Preparation of questionnaire for data collection	3	
II		**Census and Sampling**	**6**	**10**
	5	Census and Sampling	2	
	6	Principal steps in a sample survey	2	
	7	Types of sampling	1	
	8	Sampling methods	1	
III		**Random Sampling Methods**	**9**	**15**
	9	simple random sampling and without with replacement	5	
	10	Stratified random sampling (concept only)	2	
	11	Systematic Sampling (concept only)	1	
	12	Cluster sampling (concept only)	1	
IV		**Introduction to Probability**	**11**	**15**
	13	Random experiment	1	
	14	Sample space	1	
	15	event	2	
	16	Statistical regularity	3	
	17	Definition of Probability	2	
	18	Concept of conditional probability of two events	2	
V		**Exercises on Data Collection, Sample Selection, and Probability**	**9**	
	1	Data collection	**3**	
	2	Sample selection	**3**	
	3	Probability	**3**	

Books and References:

1. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi.
2. Prem. S. Mann (2010). Introductory Statistics, 7th edition, Wiley
3. Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5					3		

Programme	B. Sc. Statistics				
Course Code	STA5FS101				
Course Title	Statistical analysis using Python				
Type of Course	SEC				
Semester	V				
Academic Level	**1**00-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	HSE level Mathematics Course				
Course Summary	To make students aware of Various Quality or standards in Industrial Production, Detecting, Controlling and Maintaining Quality and Total Quality Management				

Course Outcomes CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Identify and explain the fundamental concepts of Python programming, including variables, operators, and syntax.	Remembering	Factual Knowledge	Exams, Quizzes
CO2	Utilize Pandas for data manipulation, including importing, merging, and exporting DataFrames.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze and interpret data using descriptive statistics and exploratory data analysis techniques.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Explain various data visualization libraries and their applications in representing data effectively.	Understanding	Conceptual Knowledge	Exams, Assignments
CO5	Apply statistical analysis techniques using statsmodels, including hypothesis testing and regression modeling.	Applying	Procedural Knowledge	Exams, Projects

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	**Introduction to Python Programming**		**12**	
	1	Interactive Python Environment: Jupyter notebooks, basic syntax, interactive shell	2	
	2	Data Fundamentals: Variables, assignments, arithmetic operators, expressions	3	
	3	Program Readability: Comments in code, interpreting error messages	3	
	4	Modular Programming: Importing modules, control flow statements	2	
	5	Function Fundamentals: Built-in and user-defined functions, arguments, return values, formal vs. actual parameters, named arguments	2	
II	**Data Manipulation with Pandas**		**10**	
	6	Pandas Introduction: Data Series, DataFrames	4	
	7	Data Operations: Importing, manipulating, merging, analyzing, and exporting DataFrames	4	
	9	Descriptive Statistics: Exploratory data analysis techniques	2	
III	**Data Visualization**		**8**	
	9	Data Visualization Libraries: Matplotlib, Seaborn, Plotly, ggplot, Geoplotlib, Pandas (and potentially others)	2	
	10	Plot-I : Line plot, bar plot, pie chart, box plot, histogram, strip plot, swarm plot,	3	
	11	Plot-II: Scatter plot, heatmap, density plot, cumulative frequencies, error bars	3	
IV	**Statistical Data Analysis Using statsmodels**		**18**	
	12	Random Number Generation	3	
	13	Correlation	2	
	14	Hypothesis Testing -I: One sample, two sample and paired t test	2	
	15	Hypothesis Testing -II: One way and Two way ANOVA	3	
	16	Hypothesis Testing -III: Non Parametric Tests	3	
	17	Linear Regression Modeling: Simple and multiple linear regression	3	
	18	Logistic Regression Models	2	
V	**Exercises on Numerical Methods, Machine Learning, and Web Data Scraping**		**12**	
	1	Numerical Methods with NumPy: Efficient arrays and linear algebra operations	4	
	2	Machine Learning Introduction: Fundamentals of machine learning with scikit-learn	4	
	3	Web Data Scraping: Scraping web data using requests and BeautifulSoup	4	

Books and References:

1. Embarak, D. O., Embarak, & Karkal. (2018). *Data analysis and visualization using python*. Berkeley, CA, USA: Apress.
2. Gowrishankar, S., & Veena, A. (2018). *Introduction to Python programming*. Chapman and Hall/CRC.
3. Guttag, J. V. (2016). *Introduction to computation and programming using Python: With application to understanding data*. MIT press.
4. Haslwanter, T. (2016). *An introduction to statistics with python. With Applications in the Life Sciences;* Springer International Publishing: Cham, Switzerland.
5. Lambert, K. A., & Osborne, M. (2015). *Fundamentals of PYTHON*. Cengage Learning, IE.
6. Lutz, M. (2013). *Learning python: Powerful object-oriented programming*. " O'Reilly Media, Inc.".
7. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. " O'Reilly Media, Inc.".
8. Severance, C. (2016). *Python for everybody: Exploring Data using python 3*. Charles Severance.
9. Tattar, P., Ojeda, T., Murphy, S. P., Bengfort, B., & Dasgupta, A. (2017). *Practical Data Science Cookbook*. Packt Publishing Ltd.
10. Unpingco, J. (2016). *Python for probability, statistics, and machine learning*. Cham, Switzerland: Springer International Publishing.
11. VanderPlas, J. (2016). *Python data science handbook: Essential tools for working with data*. " O'Reilly Media, Inc."

Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5					3		

Programme	B. Sc. Statistics				
Course Code	STA6FS102				
Course Title	Basic research methodology				
Type of Course	SEC				
Semester	VI				
Academic Level	**1**00-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	HSE level Mathematics Course				
Course Summary	To make students aware of research methodology.				

Course Outcomes (CO):

CO	Course Outcome	Cognitive Level	Knowledge Category	Evaluation Tools
CO1	Explain the importance and need for research ethics in the context of statistical research.	Understanding	Conceptual Knowledge	Exams, Assignments
CO2	Apply LaTeX for scientific word processing, including article preparation and thesis report formatting.	Applying	Procedural Knowledge	Projects, Practical Work
CO3	Analyze data using R programming, focusing on arrays, matrices, data frames, and probability distributions.	Analyzing	Procedural Knowledge	Exams, Case Studies
CO4	Explain the principles and advantages of simulation methods, including Monte Carlo integration and MCMC.	Understanding	Conceptual Knowledge	Exams, Assignments
CO5	Implement computer-oriented numerical methods for solving algebraic and transcendental equations, and numerical integration.	Applying	Procedural Knowledge	Projects, Practical Work

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Research in Statistics**		**12**	**15**
	1	Concept of Research in Statistics-Importance and Need for Research Ethics	2	
	2	Selection of Topic for Research-Research schedules	3	
	3	Review of Literature and its Use in Designing a Research Work-	3	
	4	Mode of Literature Survey	2	
	5	Thesis Writing – Computer Application in Scientific Research	2	
II	**Scientific Writing and Statistical Programming with LaTeX and R**		**12**	**15**
	6	Scientific Word Processing with LaTeX	2	
	7	Article, References	2	
	8	Thesis Report and Slide Preparation	2	
	9	Statistical Programming with R: Arrays and Matrices-Lists	2	
	10	Data Frames-Grouping, Loops and Conditions	2	
	11	Probability Distributions and Statistical Models in R.	2	
III	**Simulation and Monte Carlo Methods**		**15**	**25**
	112	Simulation: Concepts and Advantages of Simulation-	2	
	13	Event Type Simulation- Random Variable Generation-U(0,1)	2	
	14	Exponential, Gamma and Normal Random Variables – Monte Carlo Integration.	3	
	15	The MCMC Principle,	3	
	16	Algorithms and its Variants	2	
	17	Bootstrap Methods.	3	
IV	**Computer-Based Numerical Methods**		**9**	**15**
	18	Computer Oriented Numerical Methods	2	
	19	Algorithms for Solving Algebraic Equations	2	
	20	Algorithms for Solving Transcendental Equations	1	
	21	Numerical Integration	2	
	22	Matrix operations.	2	
V	**Research Methodology: Data Collection, Analysis, and Reporting Techniques**		**12**	
	1	Analysis of a case study	12	

Books and References:

1. Anderson, J., Durston, B.H., Pooole, M. (1970) Thesis and Assignment Writing. Wiley Eastern. Ltd., New Delhi.
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Mapping of COs with POs :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2		3					
CO3			3				
CO4				3			
CO5					3		