File Ref.No.24326/GA - IV - J2/2013/CU

UNIVERSITY OF CALICUT

Abstract

General and Academic IV- Faculty of Science- CUFYUGP Regulations 2024-B.Sc Statistics Honours Programme- Scheme and Syllabus - Implemented with effect from 2024 Admission - Subject to ratification by the Academic Council - Orders Issued.

G & A - IV - K Section

U.O.No. 9035/2024/Admn Dated, Calicut University.P.O, 11.06.2024

Read:-1.U.O.No. 3103/2024/Admn dated 22.02.2024.
2.Minutes of the meeting of the Board of Studies in Statistics-UG held on 14.04.2024.
3.Remarks of the Dean, Faculty of Science dated 01.06.2024.
4. Orders of the Vice Chancellor in the file of even No and dated 07.06.2024.

ORDER

1. The Regulations of the Calicut University Four Year UG Programmes (CUFYUGP Regulations 2024) for Affiliated Colleges, has been implemented with effect from 2024 admission onwards, vide paper read as (1) above.

2. The meeting of the Board of Studies in Statistics(UG) held on 14.04.2024, vide paper read as (2) above, has approved the scheme and syllabus of the B.Sc Statistics Honours programme in tune with CUFYUGP Regulations 2024 with effect from 2024 Admission onwards.

3. The Dean, Faculty of Science vide paper read as (3) above, has approved the minutes of the meeting of the Board of Studies in Statistics(UG) held on 14.04.2024.

4. Considering the urgency, the Vice Chancellor has approved the minutes of the meeting of the Board of Studies in Statistics(UG) held on 14.04.2024 and granted permission to implement the scheme and syllabus of the B.Sc Statictics Honours programme in accordance with CUFYUGP Regulations 2024 with effect from 2024 Admission onwards, subject to ratification by the Academic Council.

5. The scheme and syllabus of the B.Sc Statictics Honours programme in tune with CUFYUGP Regulations 2024 is implemented with effect from 2024 Admission onwards.

6. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

1.The Principals of all Affiliated Colleges,

Copy to: PS to VC/PA to PVC/ PA to R/PA to CE/JCE I/JCE IV/EX IV and EG Sections/GA IF/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

B.Sc. STATISTICS HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

B.Sc. STATISTICS HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, 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: Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Professional Skills: Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Digital Intelligence: Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Scientific Awareness and Critical Thinking: Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Human Values, Professional Ethics, and Societal and Environmental Responsibility: Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Research, Innovation, and Entrepreneurship: Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BSc Statistics (Honours) programme at Calicut University, 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 CUFYUGP

Sl. No.	**Academic Pathway**	**Major**	**Minor/ Other Disciplines**	**Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3**	**Intern -ship**	**Total Credits**	**Example**
		Each course has 4 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 Chemistry
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		(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		(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		(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		(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		(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		(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		(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		(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
		(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
		(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

		(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 MINOR COURSES IN ACTUARIAL SCIENCE

Sl. No:	Semester	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		(Preferable for Mathematics, Statistics, Commerce and Economics students)								
	1	ACT1MN101	**Actuarial mathematics I**	1	75	5	4	30	70	100
	2	ACT2MN101	**Actuarial mathematics II**	2	75	5	4	30	70	100
	3	ACT3MN201	**Risk modeling and survival analysis**	3	75	5	4	30	70	100

SINGLE MINOR - SIX COURSES IN ACTUARIAL SCIENCE

Sl. No:	Semester	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
		(Preferable for Mathematics, Statistics, Commerce and Economics students)								
1	1	ACT1MN101	**Actuarial mathematics I**	1	75	5	4	30	70	100
		ACT1MN102	**Financial Mathematics**	1	75	5	4	30	70	100
	2	ACT2MN101	**Actuarial mathematics II**	2	75	5	4	30	70	100
		ACT2MN102	**Actuarial economics**	2	75	5	4	30	70	100
	3	ACT3MN201	**Risk modeling and survival analysis**	3	75	5	4	30	70	100
		ACT3MN202	**Life contingencies**	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	-
		20	10	10	20*
	Total	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 by the University 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 anyalysis 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) is

  allowed 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 Research

  Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty member with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College 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 maximum five 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 University.
- 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 university	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
		20	5
	Total	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 by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

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 CUFYUGP 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 CUFYUGP 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 University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

* * * * * * *

B.Sc. STATISTICS HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc STATISTICS
MAJOR COURSES

SEMESTER I

Programme	B. Sc. Statistics				
Course Code	STA1CJ101(P)/STA1MN100 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe types of data To understand the various types of data and emphasize the relevance of big data in statistical analysis.	U	C	Instructor-created exams / Quiz
CO2	Illustrate (numerical data) To understand and apply measures of central tendency to describe the centre of a data se	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Visualize To analyse the spread or variability within a univariate data set using measures of dispersion	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created

				exams
CO4	Illustrate (software) To provide hands-on experience applying the concepts learned in the previous modules.	U	C	Instructor-created exams / Home Assignments
CO5	To equip students with skills in effectively presenting univariate data using tables and diagrams.	Ap	P	One Minute Reflection Writing assignments/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	Sections from References:			
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		
	Sections from References:			
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 and Moments		
	16	Kurtosis based on Moments,		
	17	Box plot		
	Sections from References:			

IV	Introduction to R		**10**	**15**
	18	R as a calculator, R preliminaries,		
	19	Getting help, data inputting methods(direct and importing from other spread sheet applications like Excel),		
	20	Statistical software and a programming language,		
	21	Data accessing, and indexing, Graphics in R, built in functions,		
	22	Saving, Storing and Retrieving work.		
	Sections from References:			
V	**Open Ended Module:** **Practical Applications, Case Study and Group Assignments**		**30**	
	1	Practical exercises 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		
	Sections from References:			

Books and References:

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
4. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	3	1	2	-	-	2	-	2	-	-	-
CO 2	3	3	-	2	1	-	3	1	2	3	-	-
CO 3	1	2	-	2	-	-	2	-	2	-	-	-
CO 4	3	2	-	1	-	-	3	-	2	2	-	-
CO	3	2	-	-	-	-	3	-	2	-	-	-

5												
CO 6	1	1	2	-	3	3	2	2	1	-	3	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

SEMESTER II

Programme	B. Sc. Statistics				
Course Code	STA2CJ101(P)/STA2MN100(P)				
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 make the student analyze Bi variate data and Examine agreement / strength of variables				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe and interpret bivariate data	U	C	Instructor-created exams / Quiz
CO2	Understand the concept of correlation and interpret their magnitude and direction	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Perform simple linear regression analysis to model the relationship beteen variables	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Identify patterns and trends in bivariate data	U	C	Instructor-created exams / Home Assignments
CO5	Apply effectively in real life situations and do analysis using R software and communicate the results.	Ap	P	One Minute Reflection Writing assignments/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45	Marks (70)

			+30)	
I	**Concept of Bivaraite 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		
	Sections from References:			
II	**Correlation**		**10**	**20**
	5	Concept, 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		
	9	Point Bi serial correlation interpretation of correlation coefficient		
	Sections from References:			
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		
	Sections from References:			
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.		
	Sections from References:			
V	**Open Ended Module: Practical Applications, Case Study and Group Assignments**		**30**	
	1	Practical exercises Hands-on using Software R: Graphical Presentations, Correlation and regression Case study using primary data in the form of Group Assignments and Discussions. Prepare record of at least 10 questions from Module I, II, III and IV using R Package		
	Sections from References:			

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 :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	-	-	-	2	3	2	-	-	-	-
CO 2	-	-	-	-	-	3	3	2	-	-	-	-
CO 3	-	-	-	-	-	2	2	3	-	-	-	-
CO 4	-	-	-	-	-	-	3	3	-	-	1	1
CO 5	-	2	-	3	2	-	2	-	1	-	2	-
CO 6	2	-	2	-	-	3	2	3	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓			✓

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	Make students aware of fundamental concepts of Mathematical Analysis,				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the concepts of Real line	U	C	Instructor-created exams / Quiz
CO2	Determine limits of Sequence and series	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Understand Convergence and Divergence	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Explain Continuity and Uniform Continuity	U	C	Instructor-created exams / Home Assignments
CO5	Derivative of functions	Ap	P	One Minute Reflection Writing assignments
CO6	visualize Theory of Integration	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)

I	**Real Line**		**16**	**20**
	1	The Order Properties of R		
	2	Absolute Value and the Real Line		
	3	The Completeness Property of R		
	4	Archimedean Property		
	5	The Existence of $\sqrt{2}$		
	6	The Density Theorem		
	7	Nested Intervals Property		
	8	Uncountability of R		
	Sections from References:			
II	**Sequences and Series**		**12**	**15**
	9	Sequence, Limit of a Sequence,		
	10	Limit Theorems, Monotone Convergence Theorem (statement only), Subsequence,		
	11	Bolzano- Weierstrass Theorem		
	12	The Cauchy Criterion, Introduction to Infinite Series,		
	13	Convergence criteria, common convergence tests.		
	Sections from References:			
III	**Function**		**10**	**20**
	14	Limit of functions		
	15	On-sided Limits,		
	16	Continuous Functions,		
	17	Bolzano's Intermediate Value Theorem,		
	18	Uniform Continuity,		
	19	Monotone and Inverse Functions		
	Sections from References:			
IV			**10**	**15**
	20	Derivative		
	21	Chain Rule		
	22	The Mean Value Theorem		
	23	Riemann Integral, Riemann Integrable Functions,		
	24	Fundamental Theorem of Calculus		
	Sections from References:			
V	**Open Ended Module:**		**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 Wiley & Sons
2. Rudin, W. (1976) Principles of Mathematical Analysis, McGraw-Hill, New York.
3. Royden, H. L. and Fitzpatrick, P. M. (2010). Real Analysis. Prentice Hall.

Programme	B. Sc. Statistics
Course Code	STA3CJ202(P)/STA3MN200 (P)

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	Make the students recall set theory, define, classify, illustrate probability theory. Discuss use of math. Expectation in variable properties				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and comprehend the fundamental concepts of probability and apply basic probability rules.	U	C	Instructor-created exams / Quiz
CO2	Define random variables, compute their probabilities, and consequently develop probability and cumulative probability distributions.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Recognize and interpret moments of a distribution through mathematical expectation	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Develop proficiency in handling probability problems using statistical software and analyzing probability distributions.	U	C	Instructor-created exams / Home Assignments
CO5	Communicate the solutions to probability problems effectively and enhance the ability to present information clearly and concisely	Ap	P	One Minute Reflection Writing assignments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive				

Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Basics of Set Theory**	**12**	**18**
	1	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		
	7	Axiomatic definition of probability and simple properties		
	8	Addition theorem (two and three events)		
	Sections from References:			
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.		
	Sections from References:			
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		
	Sections from References:			
IV		**Mathematical Expectation**	**10**	**17**
	22	Expected values of Random Variables		
	23	Raw and Central Moments (definition and relationships)		
	24	Moment generation function (MGF)		
	25	Properties of MGF		
	26	Characteristic function (definition and use only),		
	27	Moment measures of Skewness and kurtosis.		
	Sections from References:			
V		**Open Ended Module:** **Practical Applications Probability and Distributions**	**30**	
	1	Handling problems related to probability		

		Verification of function as pmf/pdf, Evaluation of moments, MGF and characteristic function (R / Mathematica-wolframcloud /sage…) Case Study Observing a random phenomenon, construction of empirical probability distribution.		
	Sections from References:			
	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.		

SEMESTER IV

Programme	B. Sc. Statistics				
Course Code	STA4CJ201(P)				
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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Apply probability concepts to model. .	U	C	Instructor-created exams / Quiz
CO2	Analyze random phenomena Analyze the corresponding distribution and its characterization.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Gain thorough idea about theoretical and practical aspects of Probability distribution	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Apply transformation of random variables to obtain new distributions.	U	C	Instructor-created exams / Home Assignments
CO5	Uses of moments, cumulates, and characteristic functions.	Ap	P	One Minute Reflection Writing assignments
CO6	Analyze the distributional properties of data using moments, skewness, and kurtosis.	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive				

Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Standard Distributions Discrete**	**10**	**16**
	1	Degenerate distribution		
	2	Bernoulli distribution (definition).		
	3	Binomial distribution (definition, properties and application).		
	4	Poisson distribution (definition, properties and application).		
	5	Relationship between Binomial and Poisson Distributions		
	Sections from References:			
II		**Standard Distributions Discrete**	**10**	**16**
	6	Discrete Uniform distribution (definition and basic properties).		
	7	Geometric distribution (definition and basic properties).		
	8	Lack of memory property of Geometric Distribution		
	9	Negative Binomial distribution (definition and basic properties).		
	10	Hyper-geometric distribution (definition and basic properties).		
	Sections from References:			
III		Standard distributions Continuous	**10**	**18**
	9	Rectangular (definition, mean, variance and mgf)		
	10	Exponential (definition, mean, variance and mgf)		
	11	Memoryless property of Exponential distribution		
	12	Gamma (definition, mean, variance and mgf)		
	13	Beta (definition, mean, variance and mgf)		
	14	Relationship between Gamma, Beta first and second distributions		
	Sections from References:			
IV		Normal distribution	**15**	**20**
	15	Definition		
	16	Derivation of Mean and Variance		
	17	Derivation of Median and Mode Mean Deviation		
	18	Derivation of MGF		
	19	Derivation of General Central Moment		
	20	Standard Normal Distribution		
	21	Normal distribution- additive property		
	22	Area properties of Normal Distribution		
	24	Computing area under standard Normal Curve		
	25	Quartile Deviation		
	26	Lognormal, Pareto Distributions (definition only).		
	27	Cauchy, Weibull and Laplace Distributions (definition only).		
	Sections from References:			
V		**Open Ended Module: Practical Applications**	**30**	
	1	Fitting of standard distributions		

		Random number generation using software		
	Sections from References:			

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.
3. Mood A.M., Graybill. F.A and Boes D.C. : Introduction to Theory of Statistics McGraw Hill
4. Johnson, N.L., Kemp, A.W., and Kotz, S.. (2005): Univariate Discrete Distributions, 5th edition, Wiley Interscience, John Wiley & Sons
5. Johnson, N.L., Kotz, S., and Balakrishnan, N. (2002): Continuous Univariate Distributions, Vol. 1, John Wiley
6. Johnson, N.L., Kotz, S., and Balakrishnan, N. (2002): Continuous Univariate Distributions, Vol. 2, John Wiley
7. Hogg, R. V., Craig, A., and Mckean, J.W. (2019): Introduction to Mathematical STATistics, 8th edition , Pearson
8. John E Freund : Mathematical Statistics (Sixth Edition), Pearson Education (India),New Delhi.

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Programme	B. Sc. Statistics
Course Code	STA4CJ202(P)

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	Make students to aware bivariate distributions and understanding BVN. Apply LLN for computing asymptotic probability				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Calculate Marginal & Conditional Probability	U	C	Instructor-created exams / Quiz
CO2	Examine Independence of two Random Variables	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Examine properties of Bivariate Normal Distribution	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Compute upper and lower bound of Probability	U	C	Instructor-created exams / Home Assignments
CO5	Discriminate sequences of Random Variables satisfying Law of Large Numbers	Ap	P	One Minute Reflection Writing assignments
CO6	Asymptotic behavior of Random Variables	Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45	Marks (70)

			+30)	
I	**Bivariate Random Variable**		**10**	**18**
	1	Joint probability mass function		
	2	Joint Probability density function		
	3	Marginal Probability functions		
	4	Conditional Probability functions		
	5	Joint Probability Distribution function		
	6	Properties of Joint Probability Distribution function		
	7	Independence of Random Variables.		
	Sections from References:			
II	Bivariate Expectation		**11**	**18**
	8	Mathematical expectation of Bivariate Random Variables,		
	9	Addition theorem of Expectation		
	10	Multiplication theorem of Expectation,		
	11	Covariance, Cauchy-Schwartz Inequality		
	12	Conditional Expectation and Conditional Variance		
	Sections from References:			
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		
	Sections from References:			
IV	**Limit Theorems**		**14**	**20**
	17	Convergence in probability		
	18	Convergence in distribution		
	19	Chebyshev's Inequality		
	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		
	24	Computation of sample size using Chebeshev's Inequality and CLT		
	Sections from References:			
V	**Open Ended Module:** **Practical Applications**		**30**	
	1	Hands-on in R: joint probability law, marginal and conditional probability functions, conditional expectation and variance, Chebyshev's inequality, WLLN, BVN		
	Sections from References:			

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

Programme	B. Sc. Statistics				
Course Code	STA4CJ203(P)				
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	Make students to apply statistical models in time series data. Importance of various indices and vital rates.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describing TS components forces affecting data.	U	C	Instructor-created exams / Quiz
CO2	Interpreting and computing trend and SI	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Relate IN for economic policy formulation	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Computation of various IN	U	C	Instructor-created exams / Home Assignments
CO5	Summarise Fertility mortality rates	Ap	P	One Minute Reflection Writing assignments
CO6	Construct Life tables	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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).		
	Sections from References:			
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		
	Sections from References:			
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)-		
	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	Fishers Ideal Index Number		
	18	Cost of Living Index Numbers-Consumer Price Index Numbers-		
	19	Family Budget enquiry		
	Sections from References:			
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		
	Sections from References:			
V		**Open Ended Module:** **Practical Applications, Case Study**	**30**	
	1	Visit of Government Organizations NSSO, DES Case study using secondary data available from government publications of Module I, II, III & IV Presentation of collected data.		
	Sections from References:			
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

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	Make students to understand standard sampling distr. Calculate point estimate and its properties construction of interval estimates				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	construct various sampling distribution To understand sampling distributions and its applications	U	C	Instructor-created exams / Quiz
CO2	interpret point estimation and its properties, interval estimation The student will be able to know various methods of estimation and applying them in practical cases.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	solve parameters using various methods of estimation	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	construct confidence intervals The students understand the concept of interval estimation and its applications	U	C	Instructor-created exams / Home Assignments
CO5	apply using software	Ap	P	One Minute

				Reflection Writing assignments
CO6	The student will be able to know point estimation and apply it in real life situations.	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	**Sampling Distributions**		**10**	**20**
	1	Definitions of 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 (derivations of distributions not required)		
	6	Mean, Variance, Moments		
	7	Snedecor's F distribution: (derivations of distributions not required)		
	8	mean, variance, mode		
	9	Relationship between z, t, F and Chi square distributions.		
	10	Sampling distributions, - distribution of sample mean and variance.		
	Sections from References:			
II	Point Estimation		**10**	**20**
	11	Estimator, Estimate Properties of good Estimator Unbiasedness, Sufficiency, Consistency and Efficiency		
	12	Factorization theorem		
	13	Complete Statistic		
	14	Minimum Variance Unbiased Estimator (MVUE) Cramer-Rao inequality(statement only)		
	15	Completeness Rao-Blackwell theorem(statement only),		
	16	Lehman Scheffe theorem (statement only),		
	17	Smple problems. MVB Estimators and their applications		
	Sections from References:			
III	Methods of Estimation		**20**	**15**
	18	Method of Moments,		
	19	Method of Maximum Likelihood Estimation		
	20	Application of order statistics in estimation		
	Sections from References:			
IV	Interval Estimation		**8**	**15**

	21	Concept of Confidence Interval		
	22	Confidence Intervals for mean of Normal population Large & small sample		
	23	Confidence Intervals for Proportion		
	24	Confidence intervals for Variance of Normal population		
	25	Confidence Interval for the difference of means and proportion		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Understanding concepts and properties from modules 1 to 4 using softwares		
	Sections from References:			

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.
1. Rohatgi, V.K. (1984) An introduction to probability theory and mathematical statistics, Wiley Eastern.
2. Wilks, S.S. (1962): Mathematical statistics - John Wiley & Sons.

Programme	B. Sc. Statistics				
Course Code	STA5CJ302(P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain need and necessity of sampling	U	C	Instructor-created exams / Quiz
CO2	Distinguish between methods of sampling	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Construct sampling based on nature of population	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Examine the efficiency of estimation	U	C	Instructor-created exams / Home Assignments
CO5	Construct random samples	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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 in sampling &Types of sampling		
	4	Concepts of Probability Proportional to Size and Random Sampling		
	5	Principal steps in Sample Survey.		
	6	Sampling and non-Sampling errors		
	Sections from References:			
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 Mean Square		
	Sections from References:			
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		
	Sections from References:			
IV			**8**	**15**
	20	Systematic sampling:		
	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		
	Sections from References:			
V	**Open Ended Module: Practical Applications**		**30**	
	1	Selection of sample and determination of sample size. Estimation of		

		mean and variance under SRSWR Estimation of mean and variance under SRSWOR Estimation of mean and variance under Stratified sampling using real life problems.		
	Sections from References:			

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.

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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	Objective make students aware of statistical hypotheses, framing of proper null and alternate hypothesis, selection of tests based conditions.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic concepts and terminologies of testing of hypothesis.	U	C	Instructor-created exams / Quiz
CO2	Understand the theory behind the statistical test construction	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Understand some specific statistical tests and their application	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Describe the situations where parametric tests cannot be used.	U	C	Instructor-created exams / Home Assignments
CO5	Understand the non-parametric alternatives of parametric tests.	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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.		
	Sections from References:			
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		
	Sections from References:			
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	Test for the significance of population variance.		
	22	Concept of ANOVA		
	Sections from References:			
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.		
	28	Chi-square test of goodness of fit		
	29	Chi-square test for independence of attributes		
	Sections from References:			
V		**Open Ended Module: Practical Applications**	**30**	
	1	All statistical tests should be done to students with simple example		

		using R or Python.		
	Sections from References:			

Books and References:

Gupta, S.C. and Kapoor, V.K. (2014): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

Christian Heumann, Michael Schomaker, Shalabh., Introduction to Statistics and Data Analysis, Springer Publications, 2016

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

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

Casella, G. and Berger R.L. (2002). : Statistical Inference, 2nd Edn. Thomson Learning

Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

SEMSTER VI

Programme	B. Sc. Statistics				
Course Code	STA6CJ301(P)				
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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Student will be able to understand the context of regression analysis	U	C	Instructor-created exams / Quiz
CO2	Capable for fitting a linear regression model to the given data	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Able to scrutinize the fitted model using the model adequacy checking	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Capable for forecasting the future values using the fitted model	U	C	Instructor-created exams / Home Assignments
CO5	Able to understand which type of regression model (linear or non-linear) is suitable	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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		
	Sections from References:			
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.		
	Sections from References:			
III			**17**	**25**
	12	Model adequacy checking		
	13	Residuals		
	14	Methods for scaling residuals,.		
	15	Residual plots,		
	16	PRESS statistic.		
	17	Detection and treatment of outliers		
	Sections from References:			
IV			**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	Concept of multicollinearity,		
	22	Sources of multicollinearity, Variance Inflation Factor		
	Sections from References:			
V		**Open Ended Module: Practical Applications**	**30**	
	1	Concept of non-linear regression, application to machine learning. Practical example of fitting a regression model using statistical software.		

	Sections from References:			

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

Programme	B. Sc. Statistics				
Course Code	STA6CJ302(P)				
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				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify various causes of variation	U	C	Instructor-created exams / Quiz
CO2	Describe models to express the resulting observation based effects and errors	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Discuss the fundamental principles of experiments	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Summarize the total variation into sum of fixed and random causes	U	C	Instructor-created exams / Home Assignments
CO5		Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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.		
	Sections from References:			
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 with a single observation per cell		
	10	Two-way ANOVA with a single observation per cell		
	Sections from References:			
III		Analysis of covariance	**17**	**20**
	11	Model of Analysis of covariance		
	12	Analysis of covariance with a single observation per cell		
	13	Experimental Designs		
	14	Terminology Unit, Material Treatment and Experimental error.		
	15	Principles of design of Experiment		
	16	Randomization		
	17	Replication		
	18	Local Control		
	Sections from References:			
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		
	Sections from References:			
V		**Open Ended Module:** **Practical Applications**	**30**	
	1	Designing Experiments, Hands on Using R, Practical Interpretation of Results. Practical problems of ANOVA		
	Sections from References:			

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

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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	Objective make students aware of random process, behaviour stationary non stationary discrete continuous indexed process transition probabilities markovian behaviour				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic probability concepts including conditional probability, generating functions and Laplace transform	U	C	Instructor-created exams / Quiz
CO2	Student will define and understand the concept of stochastic processes	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	CO3 Student will be able to know and identify different types of stochastic process based on state space and time space.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Students will analyse and model systems using discrete-time Markov chains, applying concepts such as transition probabilities, stationary distributions, and limiting behaviour	U	C	Instructor-created exams / Home Assignments
CO5	Develop proficiency in modelling systems with Poisson processes, recognizing their properties and applications across various domains	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I			**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		
	Sections from References:			
II			**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)		
	Sections from References:			
III			**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).		
	Sections from References:			
IV			**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)		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Practical problems relating to previous modules.		
	Sections from References:			

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, NewYork
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

VII SEMESTER

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 401 (P)				
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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Evaluate the Riemann-Stieltjes integral and verify the conditions for the existence of the integrals.	An	C	Instructor-created exams
CO2	Demonstrate an understanding of limits and continuity of various functions	U	F	Practical Assignment
CO3	Develop skills in generalizing the concepts in univariate calculus to multivariate setup	Ap	C	Seminar Presentation
CO4	Demonstrate proficiency in understanding and applying vector space concepts	U	F	Instructor-created exams / Home Assignments
CO5	Demonstrate proficiency in applying vector space and matrix concepts	U	F	Writing assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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- Riemanns 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		
	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- Transformations		
	19	Generalized inverse of a matrix		
	20	Matrix representations of vector spaces, bases, etc.		
	21	Idempotent matrices. Special products of matrices		
	22	Eigene values and reduction of matrices: Classification and transformations of quadratic forms. Roots of determinant equations. Canonical reduction of matrices.		
V	**Open Ended Module:**		**30**	
		Hands-on-activities using Python/R. Open book problem solving exercises		

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. **Rao,A.R. and Bhimsankaram, P. (1992)**. Linear Algebra.Tata McGraw Hill, New Delhi.

6**. Lewis, D.W. (1996).** Matrix Theory. Allied Publishers, Bangalore.

7**. Graybill, F. A. (1983).** Matrices with Applications in Statistics. John Wiley & Sons, New York.

References:

1. **Widder, D.A. (1996).** Advanced Calculus, Second Edition, Prentice Hall, Inc., New Delhi.

2. **Malik, S.C. & Arora, S. (2006).** Mathematical Analysis- Second Edition. New Age Internati International, New Delhi.

3. **Rudin, W. (1976).** Principles of Mathematical Analysis- Third Edition. McGraw Hill, New York

4. **Biswas, S. (1997).** A text book of Linear Algebra. New Age International, New Delhi.

5. **Rao, C.R. (2002).** Linear Statistical Inference and Its Applications- Second Edition. John Wiley & Sons, New York.

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 402 (P)				
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	-	3	75
Pre-requisites	Basic Probability theory, Concept of convergence				
Course Summary	Understanding expectation and various celebrated theorems in classical probability theory.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Recall sequence of sets and its convergence.	R	F	Instructor-created exams
CO2	Explain the concept of field, sigma field, Borel sigma field and monotone class.	U	C	Practical Assignment
CO3	Describe various types of measures and explain its properties.	R	C	Seminar Presentation
CO4	Explain decomposition of distribution function, characteristic function and its properties.	Ap	P	Instructor-created exams / Home Assignments
CO5	Explain the monotone convergence Theorem, Fatou's Theorem and Lebesgue dominated convergence Theorem.	Ap	P	Writing assignments
CO6	Explain the concept of convergence in probability, Convergence almost surely, Convergence in distribution, Convergence in r^{th} mean and their inter-relations.	U	F	Group Tutorial Work
CO7	Illustrate the convergence of distribution functions, Helly-Bray Lemma and Helly – Bray theorem, and Levy continuity theorem.	An	P	Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I			**10**	**20**
	1	Definition of minimal sigma field, generated sigma field and induced 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			**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			**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-Nykodym theorem.		
IV			**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	**Open Ended**		**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.

Programme	B. Sc. STATISTICS				
Course Code	STA7 CJ 403 (P)				
Course Title	DISTRIBUTION THOERY				
Type of Course	**Major**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practicaum per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Basic knowledge of various univariate and bivariate distributions. 2. 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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Distinguish different distributions and illustrate their role in modelling count data.	U	F	Seminar Presentation / Group Tutorial Work
2.	Describe the properties and applications of multivariate normal distribution.	U	C	Instructor-created exams
3.	Estimate the ML Estimates of the mean vector and dispersion matrix of multivariate normal.	An	P	Instructor-created exams
4.	Evaluate marginal and conditional distribution from multivariate normal distribution	An	P	Instructor-created exams / Home Assignments
5.	Describe the genesis of Wishart distribution with its properties.	U	C	Home Assignment
6.	Explain distribution function of random vectors, order statistics and their distributions.	Ap	C	Instructor-created exams / Home Assignments
7.	Compare Hotelling T^2 and	U	F	Instructor-created

	Mahalanobis D^2 statistic and able to apply them in testing problems.			exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Open-End**		**30**	**20**
	1	Overview of univariate & bivariate distributions and their properties. Sampling Distributions- Central and non-central (t, F and $\chi 2$) Order statistics – their distributions and properties- Joint, marginal and conditional distribution of order statistics The distribution of sample range and sample median. Problems using R/Python		
II	**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.		
III	**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.		
IV	**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		
V	**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		

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.

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 404 (P)				
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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Estimate the population parameters concerning the study variables under auxiliary information (Ratio and regression methods).	An	C	Instructor-created exams
CO2	Discuss probability proportional to size (PPS) sampling strategies.	U	F	Home Assignments
CO3	Explain the concepts of ordered and unordered estimators and its properties.	Ap	C	Instructor-created exams
CO4	Discuss the multi stage and multiphase sampling.	U	F	Seminar Presentation
CO5	Apply incomplete block designs and balanced incomplete block designs.	Ap	C	Practical Assignment
CO6	Explain factorial experiments, total confounding and partial confounding.	Ap	C	Group Tutorial Work
CO7	Differentiate between strip plot and split plot designs.	An	P	Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Open-Ended**	**30**	
		Census and Sampling-Basic concepts, probability sampling and non-probability sampling, simple random sampling with and without replacement, Systematic sampling- linear and circular systematic sampling, Stratification and stratified random sampling, Complete Block Designs. Problems using R/Python		
II	**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		
III	**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		
IV	**Incomplete Block Designs**		**11**	**20**
	12	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		
V	**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		

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.

Programme	B. Sc. STATISTICS				
Course Code	STA 7 CJ 405 (P)				
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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the method of finding sufficient statistics, minimum variance unbiased estimators, consistent estimators and consistent and asymptotically normal estimators	U	F	Instructor-created exams
CO2	Relate sufficient statistic and ancillary statistic using Basu's thorem	Ap	C	Instructor-created exams
CO3	Determine UMVUE using complete sufficient statistic using Rao- Blackwell, and Lehmann-Scheffe theorems	Ap	C	Seminar Presentation
CO4	Explain the concept of interval estimation- SELCI, Bayesian and Fiducial Intervals	U	F	Observation of Practical Skills
CO5	Construct most powerful tests using Neyman-Pearson lemma, one-sided and two-sided UMP tests and UMP unbiased tests	C	M	Group Tutorial Work
CO6	Describe the concept of α-similar tests and construct such tests	U	F	Practical Assignment
CO7	Develop SPRT for different problems	C	P	Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C), Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**Open-Ended**	**30**	
		Point Estimation. Desirable properties of a good estimator, unbiasedness, efficiency, Methods of Estimation - method of maximum likelihood, Bayesian estimation method. Testing of Hypotheses; concept of testing hypotheses, simple and composite hypotheses, null and alternative hypotheses, type I and type II errors, critical region, level of significance, power of test. Most powerful tests uniformly most powerful test, Neyman Pearson Lemma Problems using R/Python		
II	**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		
III	**Consistent asymptotically normal 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		
IV	**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		
V	**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		

Text Books

1. **Kale,B.K . and Muraleedharan K.(2015)** Parametric Inference : An Introduction, Alpha Science Intl Ltd.

2. **George Casella and Roger L Berger (2002)**. Statistical inference, Second Edition, Duxbury, Australia.

3. **Manojkumar Srivastava and Namita Srivastava(2009)**. Statistical Inference: Testing of Hypothesis, Eastern Economy Edition, PHI Learning Pvt. Ltd., New Delhi.

4. **Rohatgi, V.K(1976)**. An introduction to Probability Theory and Mathematical Statistics, John Wiley and sons, New York.

References

1. **Lehmann, E.L(1983)**. Theory of point estimation, John Wiley and sons, New York.

2. **Rohatgi, V.K (1984)**. Statistical Inference, John Wiley and sons, New York.

3. **Rao, C.R (2002)**. Linear Statistical Inference and its applications, Second Edition, JohnWiley and sons, New York.

4. **Lehman, E.L. and Romano, Joseph P.(2005)**. Testing Statistical Hypotheses. Third Edition, Springer, New- York.

SEMESTER VIII

Programme	B. Sc. STATISTICS				
Course Code	STA 8 CJ 406 (P)				
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):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Discuss the basic characteristic of a queuing system and acquire skills in analyzing queuing models	U	F	Seminar Presentation / Group Tutorial Work
2.	Analyze a network of queues	An	P	Instructor-created exams
3.	Describe the concept of renewal process and Brownian motion	U	F	Instructor-created exams
4.	Describe the basics of time series data, its auto-covariance, auto-correlation and autoregressive moving average	U	F	Instructor-created exams / Home Assignments
5.	Learn to validate a model using residual analysis	An	P	Home Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	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		
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	**Open Ended**		**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. Holden-Day

4. **BrockwellP.J.and Davis R.A. (2006)**. Time Series: Theory and Methods, Springer – Verlag.

5. **Abraham B and Ledolter J.C. (1983)**. Statistical Methods for Forecasting, Wiley

6. **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.

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	1. Good knowledge of Multivariate Normal distribution. 2. Programming skill using R.				
Course Summary	The main objective of this course are to : 1. Inculcate deep knowledge on various multivariate techniques. 2. Develop clear idea on when and where to use dependence and interdependence multivariate methods. 3. Bridge the relation between multivariate analysis using software, to strengthen statistical applications in diversified spectrum of life.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Analysing Multivariate data using reduction techniques like Principal Component Analysis, Factor Analysis and Canonical correlation.	An	P	Seminar Presentation /
2.	Formulate multivariate hypothesis tests and drawing appropriate conclusions	C	M	Instructor-created exams
3.	Discriminate multivariate normal population.	E	C	Group Tutorial Work
4.	Identify data reduction techniques	U	C	Home Assignments
5.	Analyse multivariate data using statistical software's.	An	P	Practical Skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	5	Canonical correlation – Estimation of canonical correlation and variates		
	6	Structural equation models.		
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		
	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	**Open –End**		**12**	
	Problems regarding Module I to IV using Statistical software			

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.

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 models.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Identify the general theory of GLM	U	C	Seminar Presentation /
2.	Describe the use of binary and multinomial Understand and logistic models and apply them for various data sets	R	F	Instructor-created exams
3.	Explain the concepts related to count data GLM and apply them for various count data sets.	Ap	C	Group Tutorial Work

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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	**Open –Ended**		**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. **Lindsey, J. K. (1997)**. Applying Generalized Linear Models, Springer

6. **McCullagh, P. and Nelder, J. A. (1989)**. Generalized Linear Models, Chapman & Hall

7. **McCulloch, C. E. and Searle, S. R. (2001)**. Generalized, Linear and Mixed Models, Wiley

8. **Stroup, W. W. (2013)**. Generalized Linear Mixed Models, Modern Concepts, Methods and Applications, CRC Press

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Identify the Concept of Research in Statistics, Selection of Topics, Perform Literature Review	U	F	Seminar Presentation /
2.	Express Scientific Word Processing with LaTeX and MS-Word	U	F	Instructor-created exams
3.	Develop Simulation.	Ap	C	Group Tutorial Work
4.	Compute Computer Oriented Numerical Methods	Ap	C	Home Assignments
5.	Describe Plagiarism	U	F	Practical Assignment
6.	Write Thesis	Ap	P	Observation of Practical Skills
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	**Open –Ended**		**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. **Crewley, M.J. (2007)** The R-.Book. John Wiley, New York.

6. **Dalgaard, P.(2008)**. Introductory Statistics with R. Springer Science, New York.

7. **Kothari, C. (2005)**. Research Methodology. New Age International. Publishers, New York.

8. **Lamport, L. (1999).** LATEX: A Document Preparation System. Addison, Wesley, 2nd edition, New York

9. **Panneerselvam. (2006)**. Research Methodology. Prentice-Hall of India. Pvt.,New Delhi.

10. **Robert, C.P. and Casella, G. (2004)**. Monte Carlo Statistical Methods. Springer Science, New York.

11. **Venkataraman, M.K. (1998)** Numerical Methods in Science and Engineering. The National Publishing Company, Chennai.

12. **Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., (2002)**. An Introduction to Research Methodology, RBSA publishers.

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 make students aware of Various Quality or standards in Industrial Production, Detecting, Controlling and Maintaining Quality and Total Quality Management				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understanding notion of Quality of products	U	C	Instructor-created exams / Quiz
CO2	Assessing various meaning of Quality	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Explain causes of variation and Statistical Control	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Construction of Control Charts and OC curves	U	C	Instructor-created exams / Home

				Assignments
CO5	Distinguish Process and Product Control	Ap	P	One Minute Reflection Writing assignments
CO6	Assessing Process and Product Control	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	Sections from References:			
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.		
	Sections from References:			
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		
	Sections from References:			
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		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Preliminaries of Quality Control Definition of Quality. Need of total quality Management and its uses. Causes of Variation, assessing within and between sample variation using Statistical Measures. Concept of Statistical Quality Control, Process Control and Product Control		
	Sections from References:			

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

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	Make students to formulate, solve and implement feasible solutions of complex Industrial, Trade, Commercial problems				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understanding Basics of Operations Research.	U	C	Instructor-created exams / Quiz
CO2	Distinguishing Solution, Feasible Solution, Basic Solution and Basic Feasible Solutions	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Mathematical Formulation Real life problems	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Mastering Simplex Algorithm	U	C	Instructor-created exams / Home Assignments
CO5	Apply LPP in Transportation and Assignment Problems	Ap	P	One Minute Reflection Writing assignments
CO6	Analyse decision making under conflict Game theory	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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		
	Sections from References:			
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 LCCM		
	Sections from References:			
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		

	Sections from References:			
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		
	Sections from References:			
V	**Open Ended Module:**		**12**	**15**
	1	Origin, Development of OR. Nature & Scope of OR, Uses & Limitations of OR. Linear Programming Problem, Mathematical Formulation, General, Standard form of LPP.		
	Sections from References:			

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***

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 describe the need and ethics of clinical trials and designs for various phases of clinical trials.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	The student will explain Principles of Biostatistical study designs	U	C	Instructor-created exams / Quiz
CO2	The student will explain measures of morbidity.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	The student will describe the concepts of survival time functions of important parametric models.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	The student will explain types of censoring and estimation of parameters using censored data.	U	C	Instructor-created exams / Home Assignments
CO5	The student will explain the non-parametric methods for estimating survival function and variance of the estimator using Kaplan –Meier methods.	Ap	P	One Minute Reflection Writing assignments
CO6	The student will describe the basic biological concepts in genetics.	Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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.		
	Sections from References:			
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,		
	13	Survival distributions- exponential distribution, Weibull distribution and lognormal distribution.		
	Sections from References:			
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.		
	Sections from References:			
IV			**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)		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Practical problems based on module I to IV using statistical software.		
	Sections from References:			

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.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	will be able to estimate and interpret linear regression models and be able to distinguish between economic and statistical importance.	U	C	Instructor-created exams / Quiz
CO2	They should be able to use a statistical/econometric computer package to estimate an econometric model	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	To understand the scope and application of econometrics to real world problems.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	To know econometric problems and their solutions	U	C	Instructor-created exams / Home Assignments
CO5	Student also will be exposed to simple statistical packages and their use in econometric work	Ap	P	One Minute Reflection Writing

				assignments
CO6		Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	Sections from References:			
II	Heteroscedasticity		**12**	**20**
	6	Econometric problems		
	7	Heteroscedasticity		
	8	Tests for heteroscedasticity,		
	9	Consequences of heteroscedasticity and solutions		
	Sections from References:			
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		
	Sections from References:			

IV	Multiple regression		**14**	**20**
	16	Concept of Multiple regression		
	17	Multiple regression analysis.		
	18	Multi collinearity: Introduction and concepts,		
	19	Detection of multi collinearity,		
	20	Consequences multi collinearity		
	21	Sources multi collinearity		
	22	Tests and estimation of multi collinearity		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Practical Problems related to OLS/ CLR using softwares. Introduction to various Economic functions (Demand , Supply, Utility, Cost , Revenue etc.)		
	Sections from References:			

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

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	Aware students the role of the subject Statistics in National Policy Formulation, Planning and framing of various policies by the Governments				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the roles and responsibilities of various central and state organizations.	U	C	Instructor-created exams / Quiz
CO2	Explain the methods of data collection and dissemination in the official setup	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Explain the population growth in developed and developing countries	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Explain Statistics related to Industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics	U	C	Instructor-created exams / Home Assignments
CO5	Explain the National income estimation by various approaches.	Ap	P	One Minute Reflection Writing assignments
CO6	Describe Lorenz curve, Gini Coefficient and Theil's measure of income inequality			
CO7	Practical: Use R built in functions to solve	Ap	P	Viva Voce

	numerical problems associated with topics covered in various modules			

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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.		
	Sections from References:			
II			**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		
	Sections from References:			
III			**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		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Prepare a report based on Wealth – Income distribution disparities		
	Sections from References:			

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.

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	Learn both how to clean longitudinal data as well as the main statistical models used to analyse it. The course will cover three fundamental frameworks for analysing longitudinal data: multilevel modelling, structural equation modelling and event history analysis.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic concepts of Linear Model in longitudinal data analysis	U	C	Instructor-created exams / Quiz
CO2	Analyze numerical methods to solve the problems in Linear Model	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Explain the basic concepts of Generalized Linear Model	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Illustrate and study on missing data mechanism in longitudinal data analysis	U	C	Instructor-created exams / Home Assignments
CO5	Analyze longitudinal data using any statistical software	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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		
	Sections from References:			
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		
	Sections from References:			
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		
	Sections from References:			
IV			**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		
	Sections from References:			
V	**Open Ended Module:**		**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)		
	Sections from References:			

Books and References:

Diggle, P.J., Heagerty, P., Liang, K.Y and Zeger. S.L (2003). Analysis of Longitudinal Data- Second Edition. Oxford University Press, London.

1. Fitzmaurice,M., Laird,M. and Ware, H. Applied Longitudinal Analysis- Second Edition. John Wiley & Sons, New Jersey.

2. Crowder, M.J. and Hand, D.J. (1990). Analysis of Repeated Measures. Chapman and Hall/CRC Press, London.

3. Hand, D and Crowder, M. (1996). Practical Longitudinal Data Analysis. Chapman and Hall/CRC Press, London.

4. Lindsey, J.K. (1993) Models for Repeated Measurements. Oxford University Press, London.

5. Little, R.J.A, and Rubin, O.B. (2019). Statistical Analysis with Missing Data- Third Edition. John Wiley & Sons, New York.

6. McCullagh, P. and Nelder, J.A (1989). Generalized Linear Models- Second Edition. Chapman and Hall/CRC Press, London.

7. Weiss, R.E. (2005). Modeling Longitudinal Data. Springer, New York

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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	Statistical Methods to model and analyse a variety of Random Phenomena				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Generate pseudo-random numbers using different methods.	U	C	Instructor-created exams / Quiz
CO2	Use resampling methods on real datasets.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Apply Markov Chain Monte Carlo methods and density estimation	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Develop programs for simulation purposes.	U	C	Instructor-created exams / Home Assignments
CO5	Apply simulation skills in real-world scenarios	Ap	P	One Minute Reflection Writing assignments

CO6		Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I			**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		
	Sections from References:			
II			**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))		
	Sections from References:			
III			**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	Jackknife in sample surveys,		
	16	Theory for the bootstrap and its consistency, Distribution and variance estimators (Shao & Tu (2012), Rizzo (2019))		
	Sections from References:			
IV			**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		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Generate random numbers using statistical software for different distributions with its estimation and model fitting. Apply resampling methods for real life data.		
	Sections from References:			

Books and References:

1. Rizzo, M. L. (2019). Statistical Computing with R, second edition. Boca Raton, FL: Chapman & Hall/CRC Press

References

2. McLachlan, G.J. and Krishnan, T. (1997): The EM Algorithms and Extensions, Wiley.
3. Robert, C.P. & Casella, G. (2004) Monte Carlo Statistical Methods, 2ndEdn., Springer.
4. Ross, S. M. (2022). Simulation. Academic Press.
5. Rubinstein, R.Y. (2017). Simulation and the Monte Carlo Methods, Wiley.
6. Shao, J., & Tu, D. (2012). The jackknife and bootstrap. Springer Science & Business Media.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the structural properties of coherent systems.	U	C	Instructor-created exams / Quiz
CO2	Determine the reliability of a system.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Discuss the different parametric distributions in reliability	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Discuss the lifetime of a system based on ageing properties	U	C	Instructor-created exams / Home Assignments
CO5	Discuss different censoring schemes.	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive				

Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I			**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		
	Sections from References:			
II			**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		
	Sections from References:			
III			**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.		
	Sections from References:			
IV			**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	**Open Ended Module:**		**12**	
	1	Estimation and testing based on these schemes for various parametric models.		
	Sections from References:			

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 Mode 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 Metho New York: Springer-Verlag.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic concepts and ideas of survival analysis.	U	C	Instructor-created exams / Quiz
CO2	Examine the properties and methods for standard survival time distributions	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Estimate survival functions using parametric and non-parametric methods.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Apply and interpret semi-parametric and parametric regression models for survival data.	U	C	Instructor-created exams / Home Assignments
CO5	To apply the concepts learned in the previous modules to a real-life data set.	Ap	P	One Minute Reflection Writing assignments

CO6		Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I			**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.		
	Sections from References:			
II			**10**	**15**
	5	Right censoring		
	6	Left censoring		
	7	Interval censoring		
	8	Truncation		
	9	Likelihood construction for censored and truncated data.		
	Sections from References:			
III			**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.		
	Sections from References:			
IV			**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		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	**Practical exercises on lifetime data using the statistical software R: Fitting the Parametric models for survival data.**		
	Sections from References:			

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.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand various sources of demographic data	U	C	Instructor-created exams / Quiz
CO2	Understand life tables and their main features	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Calculate and interpret mortality and fertility measures	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Analyze internal migration and its measurement, exploring migration models	U	C	Instructor-created exams / Home Assignments
CO5	Apply demographic concepts and measures practically using data analysis tools like R or Excel.	Ap	P	One Minute Reflection Writing assignments
CO6		Ap	P	Viva Voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I			**10**	**15**
	1	Sources of demographic data		
	2	Census and Registration		
	3	Ad-hoc surveys, Hospital records		
	4	Demographic profiles of the Indian Census.		
	Sections from References:			
II			**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.		
	Sections from References:			
III			**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		
	Sections from References:			
IV			**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		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	**Hands-on in R or Excel: Mortality and fertility measures.**		
	Sections from References:			

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

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Discuss future life time distributions and their probabilities.	U	C	Instructor-created exams / Quiz
CO2	Know the concept of life table.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Apply different kinds of interest rates expressed in different time periods.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Understand the basics life assurance and life annuity contracts.	U	C	Instructor-created exams / Home Assignments
CO5	Understand the utility theory, insurance products and life tables.	Ap	P	One Minute Reflection

	Understand the concept of interest.			Writing assignments
CO6	: Understand the concept of life insurance and the existing insurance products of different insurance company. Know life annuities, net premium and net premium reserves	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	Sections from References:			
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		
	Sections from References:			
III	**Rates of interests 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		
	Sections from References:			
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		
	Sections from References:			
V	**Open Ended Module:**		**12**	
	1			
	Sections from References:			

Books and References:

Textbook:

1. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, Universities Press.

Reference:

1. Rotar, V.I. (2015). Actuarial Models – The mathematics of Insurance – Second Edition. CRC Press, New York.

2. Promislow, S.D. (2015). Fundamentals of Actuarial Mathematics- Third Edition. John Wiley & Sons, New York.

3. Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A.& Nesbitt, C.J. (1997). Actuarial Mathematics, Society of Actuaries.

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	Basic knowledge in Statistics and programming skills in Python				
Course Summary	Understanding Machine learning using Statistics				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Describe the application of statistical concepts and methods in machine learning	U	F	Seminar Presentation /
2.	Apply various popular machine learning methods to practical situations	Ap	C	Instructor-created exams
3.	Apply the model assessment methods in machine learning techniques	Ap	P	Group Tutorial Work
4.	Connect computing software into machine learning problems	An	P	Home Assignments
5.	Explain basic concepts of Neural Networks in machine learning	U	F	Practical Skill
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	**Open –Ended**		**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 Learning in Python. Packt Publishing, UK

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	Good idea about Linear Programming Problems				
Course Summary	Understand advanced models of Linear Programming Problems and Non-Linear Programming Problems.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Express theoretical knowledge of Simplex method for solving Linear Programming Problems and Expertise with Revised Simplex method and Dual Simplex method.	U	F	Seminar Presentation /
2.	Develop and solve Integer Programming Models.	Ap	C	Instructor-created exams
3.	Identify Classical Optimization techniques and Non- linear Programming techniques.	U	F	Group Tutorial Work
4.	Formulate Network models like PERT and CPM to improve decision making and develop critical thinking objective analysis of decision making.	Ap	C	Home Assignments
5.	Develop and solve Inventory Models and acquire skills in analyzing Queuing Models.	Ap	C	Practical Skill
6.	Estimate the allocation of resources to demand points in the best possible way using various techniques and minimize the cost or time of completion of jobs.	An	P	Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Theory of Simplex Method & Revised Simplex Method**		**12**	**20**
	1	Canonical and Standard form of LP problem		
	2	Canonical and Standard form of LP problem- 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	**Open –Ended**		**12**	
	Sequencing Problem, Replacement and Maintenance Models Simulation Techniques			

Reference

1. **Mital. K. V. and Mohan. C. (1996).** Optimization Methods in OperationsResearch 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.

3. **Sharma J.K. (2003).** Operations Research-Theory and Applications, Macmillan Indian Ltd., New Delhi

4. **Man Mohan, Kanti Swarup and Gupta (1999).** Operations Research, Sulthan Chand & Sons, New Delhi.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Identify basic concepts of queueing theory	U	F	Seminar Presentation
2.	Analyze behaviors of queueing models	An	P	Instructor-created exams
3.	Explain on queueing networks	Ap	F	Group Tutorial Work
4.	Apply queueing models	Ap	F	Home Assignments
5.	Evaluate performance measures	An	P	Practical Skill
6.	Create significance and applications of queueing theory	C	M	Group Tutorial Work
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	**Open –Ended**		**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.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Explain different loss functions and decision principle	Ap	C	Seminar Presentation /
2.	Describe the use of prior information in decision making.	R	F	Instructor-created exams
3.	Calculate Posterior distribution and check the admissibility of Bayes rules	Ap	C	Group Tutorial Work
4.	Develop general techniques for solving games	Ap	C	Home Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	**Open –Ended**		**12**	
	Problems regarding Module I to Module IV			

Text Book

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.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Appraise the basic concepts of clinical trials	E	P	Seminar Presentation /
2.	Plan and develop the design of clinical trials	An	C	Instructor-created exams
3.	Determine the sample size in clinical trials	Ap	C	Group Tutorial Work
4.	Conduct bioassays and assimilate the concepts of meta-analysis in clinical trials	Ap	C	Home Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	**Open –Ended**		**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

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 unsupervisory learning				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Explain the concept of EM clustering algorithms.	U	F	Seminar Presentation /
2.	Understand the classification techniques and the concept of support vector machines	U	F	Instructor-created exams
3.	Explain the basic concepts related to big data	Ap	C	Group Tutorial Work
4.	Illustrate the multidimensional scaling techniques in unsupervised learning	Ap	C	Home Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	Met 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	**Open –Ended**		**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 withApplications in R. Springer, New York.

3. **Erl, T. and Khattak, W. (2016)**. Big Data Fundamentals Concepts, Drivers & Techniques. Prentice Hall.

4. **Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E.(2009)**. Multivariate Data Analysis, 7thedition. Prentice Hall, New York.

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
1.	Discuss the Johnson's S_B system, Johnson's system S_u and Burr family of distributions.	U	F	Seminar Presentation
2.	Identify the general theory of infinite divisibility and its applications	U	F	Instructor-created exams
3.	Explain the concept and properties of U-statistics, and their role in non-parametric modelling	An	P	Group Tutorial Work
4.	Describe various types stochastic order relations between random variables in univariate setup.	U	C	Home Assignments
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	U**nivariate 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	**Open –Ended**		**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

	University of Calicut
	Four Year UG Program **Syllabus - Minor**

Programme	BSc Statistics				
Course Code	STA1MN101 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe different types of data	U	F	Instructor-created exams / Quiz
CO2	Compare and differentiate various types of data	U	C	Instructor-created exams / Home Assignments
CO3	Visualize different types of data and analyze data to help entrepreneurial decisions using critical thinking skills.	R	P	Seminar Presentation / Group Tutorial Work
CO4	Summarize various descriptive measures of data and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Define basic terms in probability	R	F	One Minute

				Reflection Writing assignments
CO6	Solving uncertainty with sample data with spread sheet	Ap	P	Viva-Voce/Practical Assignment/Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 1.2&1.3 [Ref 3] Unit 2: 2.2 [Ref 2] Unit 3: 2.3 [Ref 2] Unit 4: 2.5 [Ref 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	
	Sections from References: Unit 5: 3.3 [Ref 2] Unit 6: 3.5 [Ref 2] Unit 7: 4.3(4.3.2 to 4.3.7) - [Ref 2] Unit 8: 4.4(4.4.3 to 4.4.5)- [Ref 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	
	Sections from References: Unit 9: 2.4 [Ref 1] Unit 10: 2.5 [Ref 1] Unit 11: 2.6, 2.7 [Ref 1] Unit 12: 2.8, 2.9 [Ref 1] Unit 13: 2.11 [Ref 1] Unit 14: 2.13 [Ref 1] Unit 15: 2.16, 2.17 [Ref 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	
	Sections from References: Unit 16: 3.3, 3.4, 3.5, 3.6 & 3.8 [Ref 1] Unit 17: 3.9 [Ref 1] Unit 18: 3.10[Ref 1] Unit 19: 3.11 [Ref 1] Unit 20: 3.12, 3.13& 3.14 [Ref 1] Unit 21: 3.15[Ref 1] Unit 22: 4.2 [Ref 1]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 1.2 Ref [5] Unit 2: 1.4 Ref [5] Unit 3: 2.1 Ref [5] Unit 4: 2.2 Ref [5] Unit 5: 2.3 Ref [5] Unit 6: 3.1 Ref [5] Unit 7: 3.2 Ref [5] Unit 8: 3.3 Ref [5]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	3	1	2	-	-	2	-	2	-	-	-
CO 2	3	3	-	2	1	-	3	1	2	3	-	-
CO 3	1	2	-	2	-	-	2	-	2	-	-	-
CO 4	3	2	-	1	-	-	3	-	2	2	-	-
CO 5	3	2	-	-	-	-	3	-	2	-	-	-
CO 6	1	1	2	-	3	3	2	2	1	-	3	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN101 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define random variables and distinguish different types of random variables	R	C	Instructor-created exams / Quiz
CO2	Identify discrete and continuous probability function and analyze data to help entrepreneurial decisions using critical thinking skills.	R	C	Practical Assignment / Instructor-created exams
CO3	Describe standard theoretical distributions	R	F	Seminar Presentation / Group Tutorial Work/Instructor-created exams
CO4	Discuss various tools for association between the bivariate variables.	U	C	Instructor-created exams / Home Assignments
CO5	Distinguish between a population distribution and a sampling distribution and critically evaluate ethical implications of statistical methods aligning with human values.	U	F	One Minute Reflection Writing assignments, Instructor-created exams
CO6	Explain the calculation of correlation	U	P	Viva

	coefficent using spread sheet.			Voce/Instructor -created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 5.1 & 5.3 [Ref 1] Unit 2: 5.3.1 [Ref 1] Unit 3: 5.2, 5.2.1,5.3.2[Ref 1] Unit 4: 6.1,6.2,6.3,6.4 [Ref 1] Unit 5: 6.3 [Ref 1] Unit 6: 6.6 [Ref 1] Unit 7: 7.1,7.1.2 [Ref 1] Unit 8: 8.4, 8.4.1 [Ref 1] Unit 9: 8.5, 8.5.2 [Ref 1]			
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	
	Sections from References: Unit 10: 5.4, 5.4.1, 5.4.2 [Ref 1] Unit 11: 9.3.1 [Ref 1] Unit 12: 9.8, 9.8.1[Ref 1] Unit 13: 9.2, 9.2.5, 9.2.7, 9.2.8, 9.2.11[Ref 1]			
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	
	Sections from References: Unit 14: 10.1, 10.2, 10.3, 10.4, 10.4.1, 10.4.2 [Ref 1] Unit 15: 11.1, 11.2, 11.2.1, 11.2.2 [Ref 1] Unit 16: 11.2.6 [Ref 1] Unit 17: 11.3 [Ref 1]			
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	
	Sections from References: Unit 18: 14.3, 14.3.1, 14.3.2 [Ref 1] Unit 19: 4.2 [Ref 3] Unit 20: 4.3 [Ref 3] Unit 21: 4.4 [Ref 3] Unit 22: 4.5 [Ref 3]			
V	**PRACTICUM**		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		
	Sections from References: Unit 1: 2.4 [Ref 5] Unit 2: 2.4 [Ref 5] Unit 3: 2.4 [Ref 5] Unit 4: 4.4 [Ref 5] Unit 5: 4.5 [Ref 5] Unit 6: 5.1 [Ref 5] Unit 7: 5.2 [Ref 5] Unit 8: 5.3 [Ref 5]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	-	-	-	2	3	2	-	-	-	-
CO 2	-	-	-	-	-	3	3	2	-	-	-	-
CO 3	-	-	-	-	-	2	2	3	-	-	-	-
CO 4	-	-	-	-	-	-	3	3	-	-	1	1

CO 5	-	2	-	3	2	-	2	-	1	-	2	-
CO 6	2	-	2	-	-	3	2	3	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓			✓

Programme	BSc Statistics
Course Code	STA3MN201 (P)

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Articulate the purpose of estimation in making inferences about population parameters based on sample data and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	C	Instructor-created exams / Quiz
CO2	Explain the difference between point estimation and interval estimation	U	C	Practical Assignment / Observation of Practical Skills
CO3	Calculate and interpret confidence intervals for both population mean and proportion and critically evaluate ethical implications of statistical methods aligning with human values	Ap	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Explain how to formulate null and alternative hypotheses for different types of research questions	U	C	Instructor-created exams / Home Assignments
CO5	Introduce R software and discuss R code for various graphical representations of data.	U	F	One Minute Reflection Writing assignments/ Instructor-creat

				ed exams
CO6	Apply estimation and hypothesis testing methods to real-world data sets.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 16.1, 16.2, 16.2.1 [Ref 1] Unit 2: 16.2.2 [Ref 1] Unit 3: 16.2.3 [Ref 1] Unit 4: 16.2.4 [Ref 1] Unit 5: 16.6.5 [Ref 1] Unit 6: 16.2.6 [Ref 1] Unit 7: 16.4 [Ref 1] Unit 8: 16.4.2 [Ref 1] Unit 9: 16.4.3 [Ref 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 tatiled and two tailed	2	

		tests		
	12	Large sample tests: Test for single proportion	3	
	13	Test of significance for a single mean	3	
	Sections from References: Unit 10: 16.6.1 [Ref 1] Unit 11: 16.6.3, 16.6.4, 16.6.5, 16.6.6, 16.6.7, 16.6.8 [Ref 1] Unit 12: 17, 17.2.1 [Ref 1] Unit 13: 17.3.2 [Ref 1]			
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	
	Sections from References: Unit 14: 18.3 [Ref 1] Unit 15: 18.4 [Ref 1] Unit 16: 18.6 [Ref 1]			
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	
	Sections from References: Unit 19: 1.2&1.3 [Ref 5] Unit 20: 1.4 [Ref 5] Unit 21: 1.5&1.6 [Ref 5] Unit 22: 1.8,2.3 [Ref 5] Unit 23:2.2 [Ref 5] Unit 24: 2.4,2.5 [Ref 5]			
V	**PRACTICUM**		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		
	Sections from References: Unit 1: 1.3&1.4 [Ref 5] Unit 2: 1.5 [Ref 5] Unit 3: 1.6 [Ref 5] Unit 4: 1.7 [Ref 5] Unit 5: 1.8 [Ref 5] Unit 6: 2.2 [Ref 5] Unit 7: 2.4 [Ref 5] Unit 8: 2.5 [Ref 5]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	1	-	-	2	2	3	-	-	3	-
CO 2	-	2	-	3	2	3	3	3	1	-	-	-
CO 3	2	-	2	-	-	-	2	2	-	3	-	3

CO 4	-	-	3	-	-	-	1	3	-	3	-	-
CO 5	-	-	2	-	-	-	1	3	-	3	-	-
CO 6	2	-	2	-	-	-	1	2	-	2	-	2

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics

Course Code	STA1MN102 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the importance of sampling as a method for gathering data and making inferences about populations	U	C	Instructor-created exams / Quiz
CO2	Describe the ability to implement simple random sampling techniques and understand their advantages and limitations.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Develop skills in interpreting index numbers and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	C	Seminar Presentation / Group Tutorial Work
CO4	Explain the significance of vital statistics in capturing essential demographic information and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Understand various methods of collecting vital statistics.	R	F	One Minute Reflection Writing assignments/ Instructor-create

				d exams
CO6	Demonstrate the ability to write and execute simple R scripts.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 15.2,15.3,15.6 [Ref 1] Unit 2: 15.6,15.7[Ref 1] Unit 3: 15.8 [Ref 1] Unit 4: 15.9.1[Ref 1] Unit 5:15.10[Ref 1] Unit 6:15.11,15.11.1 [Ref 1] Unit 7: 15.12,15.12.1 [Ref 1] Unit 8: 15.13 [Ref 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	
	Sections from References: Unit 9: 10.1&10.2[Ref 1] Unit 10: 10.3 [Ref 1] Unit 11: 10.4[Ref 1] Unit 12: 10.5 [Ref 1] Unit 13:10.6.2&10.6.3 [Ref 1]			
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	
	Sections from References: Unit 14: 16.2 [Ref 2] Unit15: 16.2&16.3 [Ref 2] Unit 16: 16.3&16.4[Ref 2] Unit 17: 16.5&16.6 [Ref 2] Unit 18:16.14,16.15,16.16,16.18 [Ref 2]			
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)		
	Sections from References: Unit 19: 1.2&1.3 [Ref 5] Unit 20: 1.4 [Ref 5] Unit 21: 1.5&1.6 [Ref 5] Unit 22: 1.8,2.3 [Ref 5] Unit 23:2.2 [Ref 5] Unit 24: 2.4,2.5 [Ref 5]			
	PRACTICUM			
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		
	Sections from References: Unit 1: 1.3&1.4 [Ref 5] Unit 2: 1.5 [Ref 5] Unit 3: 1.6 [Ref 5] Unit 4: 1.7 [Ref 5] Unit 5: 1.8 [Ref 5] Unit 6: 2.2 [Ref 5] Unit 7: 2.4 [Ref 5] Unit 8: 2.5 [Ref 5]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	2	2	2	-	-	-	-
CO 2	-	-	-	-	-	2	1	2	-	-	-	-
CO 3	-	-	3	-	-	3	3	2	-	2	3	-
CO 4	2	2	-	3	2	-	2	2	2	-	-	3
CO 5	2	2	-	-	-	-	1	1	-	-	-	-
CO 6	-	2	-	-	-	3	2	1	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA2MN102 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and explain the concept of bivariate random variables.	U	C	Instructor-created exams / Quiz
CO2	Explore the concept of joint and marginal probability density functions	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Calculate bivariate expectations for various functions of two random variables	Ap	F	Seminar Presentation / Group Tutorial Work/Instructor-created exams
CO4	Identify and describe common standard distributions like rectangular, beta, gamma and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Home Assignments
CO5	Identify the importance of time series analysis and explain various components of time series and critically evaluate ethical implications of statistical methods aligning with human values.	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Locate probability curves for different distributions using R	Ap	P	Viva Voce/ Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

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	
	Sections from References: Unit 1: 5.5 [Ref 1] Unit 2: 5.5.1 & 5.5.4 [Ref 1] Unit 3: 5.5.2 [Ref 1] Unit 4: 5.5.1 & 5.5.4[Ref 1] Unit 5:5.5.1 & 5.5.5 [Ref 1] Unit 6:.5.5.6 [Ref 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	
	Sections from References: Unit 7: 6.4 [Ref 1] Unit 8: 6.5 [Ref 1] Unit 9: 6.6&10.4 [Ref 1] Unit 10: 6.9[Ref 1]			
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	
	Sections from References: Unit 11: 8.2 [Ref 1] Unit 12: 8.7 [Ref 1] Unit 13: 8.8 [Ref 1] Unit 14: 8.6[Ref 1] Unit 15: 9.3[Ref 1] Unit 16:.9.5 [Ref 1] Unit 17:.9.6,9.7 [Ref 1] Unit 18:.9.18 [Ref 1]			
IV		**TIME SERIES ANALYSIS**	10	20
	19	Introduction to Time Series & Utility of Time Series	1	
	20	Components of Time Series	1	
	21	Measurment 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	
	Sections from References: Unit 19: 11.1& 11.3[Ref 2] Unit 20:11.2[Ref 2] Unit 21:.11.5[Ref 2] Unit 22:.11.6 [Ref 2]			
V	**PRACTICUM**		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	Obatain any one discrete probability		
	8	Obatain any one continuous probability		
	Sections from References: Unit 1: 2.6 [Ref 5] Unit 2: 2.6 [Ref 5] Unit 3: 3.2, 3.3 [Ref 5] Unit 4:3.2, 3.3 [Ref 5] Unit 5: 3.2, 3.3 [Ref 5] Unit 6: 3.2, 3.3 [Ref 5] Unit 7: 3.4 [Ref 5] Unit 8: 3.6 [Ref 5]			

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 PSOs and POs :

	PSO	PSO	PSO	PSO4	PSO	PSO6	PO	PO2	PO3	PO4	PO5	PO6

	1	2	3		5		1					
CO 1	2	3	-	-	-	3	1	2	2	-	-	-
CO 2	-	2	-	-	-	-	2	-	-	-	-	-
CO 3	-	3	-	2	2	2	1	2	-	-	-	-
CO 4	-	-	3	-	-	3	3	-	1	3	3	-
CO 5	3	-	-	-	-	2	3	1	-	-	-	3
CO 6	-	-	-	-	-	2	2	3	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA3MN202 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Introduce and explore different law of large numbers	U	C	Instructor-created exams / Quiz
CO2	Define and understand the rationale for testing differences between two populations	R	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Formulate null and alternate hypothesis for a real life two population problem and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Differentiate between one-way and two-way ANOVA and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Define and understand the principles of non parametric statistics	U	F	One Minute Reflection Writing assignments/

				Instructor-created exams
CO6	Describe analysis of variance and hypothesis testing using R software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 7.5 [Ref 1] Unit 2: 7.6 [Ref 1] Unit 3: 7.7 [Ref 1] Unit 4:7.7 [Ref 1] Unit 5: 7.8[Ref 1] Unit 6: 9.16[Ref 1]			
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	
	Sections from References: Unit 6: 14.7.2 [Ref 1] Unit 7: 14.8.4 [Ref 1] Unit 8: 16.3.2 [Ref 1] Unit 9: 16.3.3[Ref 1] Unit 10: 16.7[Ref 1]			
III	**ANALYSIS OF VARIANCE**		8	15
	11	ANOVA	1	
	12	One-Way Analysis of Variance	3	
	13	Two -Way Analysis of Variance	4	
	Sections from References: Unit 11: 23.1,23.2 [Ref 2] Unit 12: 23.3[Ref 2] Unit 13: 23.4[Ref 2]			
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	
	Sections from References: Unit 14: 26.2[Ref 2] Unit 15:26.2.1 [Ref 2] Unit 16: 26.3[Ref 2] Unit 17: 26.4 [Ref 2] Unit 18:26.5 [Ref 2] Unit 19:26.7[Ref 2] Unit 20: 26.8[Ref 2] Unit 21: 26.9[Ref 2]			

V	**PRACTICUM**		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		
	Sections from References: Unit 1: 4.4 [Ref 5] Unit 2: 4.5 [Ref 5] Unit 3: 4.6 [Ref 5] Unit 4: 5.2 [Ref 5] Unit 5: 5.3 [Ref 5] Unit 6: 5.4 [Ref 5] Unit 7: 5.5 [Ref 5] Unit 8: 5.8 [Ref 5]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	-	-	-	3	1	2	-	-	-	-
CO 2	2	-	-	-	-	2	2	1	-	-	-	-
CO 3	-	-	2	-	-	2	2	-	-	1	3	-
CO 4	2	-	-	-	-	-	2	1	-	-	-	3
CO 5	-	3	-	2	3	3	-	2	1	-	-	-
CO 6	-	-	-	-	-	2	3	1	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA1MN103 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify data types and construct frequency distributions.	U	C	Instructor-created exams / Quiz
CO2	Create diverse graphical representations effectively and critically evaluate ethical implications of statistical methods aligning with human values.	Ap	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Calculate and apply central tendency measures practically and analyze data to help entrepreneurial decisions using critical thinking skills..	Ap	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Use measures of central tendency to summarize and describe data, demonstrating the ability to communicate the findings in both written and graphical formats	U	C	Instructor-created exams / Home Assignments
CO5	Master R programming basics and descriptive statistics.	Ap	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Implement R for practical data analysis and graphical representation.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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	
	Unit 1:2.2,11.1,2.1 Ref[1] Unit 2: 2.2 Ref[1] Unit 3: 3.5 Ref[3]			
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	
	Unit 4: 4.3.3 Ref[3] Unit 5:4.3.4, 4.3.6 Ref[3] Unit 6: 4.4.3 Ref[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	
	Unit 7: 5.4 Ref[3] Unit 8: 5.6.1 Ref[3] Unit 9: 5.7.1 Ref[3] Unit 10: 5.9 Ref[3] Unit 11: 5.10 Ref[3]			
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	
	Unit 12: 1.1 Ref[2] Unit 13: 2.2 Ref[2] Unit 14: 2.3 Ref[2] Unit 15: 3.3 Ref[2] Unit 16: 3.6 Ref[2] Unit 17: 4.2 Ref[2] Unit 18: 4.4 Ref[2] Unit 19: 1.5 Ref[2] Unit 20: 4.5 Ref [2] Unit 21: 2.5 Ref[2] Unit 22: 2.6 Ref[2]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 7.2 Ref[2] Unit 2: 7.2Ref[2] Unit 3: 7.2Ref[2] Unit 4: 7.2Ref[2] Unit 5: 7.3Ref[2] Unit 6: 7.4 Ref[2] Unit 7: 7.5.1 Ref[2] Unit 8: 7.5.2 Ref[2]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	-	-	-	2	2	2	-	-	-	-
CO 2	-	2	-	3	2	3	-	3	1	-	3	-
CO 3	-	2	-	2	-	2	1	2	2	-	-	3
CO 4	-	-	-	-	-	1	3	1	-	-	-	-
CO 5	-	-	3	-	-	-	2	-	2	3	-	-
CO 6	2	-	-	-	-	2	1	-	1	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN103 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Utilize dispersion measures effectively in practical scenarios and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Quiz
CO2	Demonstrate mastery in correlation, regression, and their applications and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Comprehend and employ basic probability concepts and theorems.	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Explain fundamental concepts of probability theory including events, saple space, outcomes.	U	C	Instructor-created exams / Home Assignments
CO5	Understand and employ conditional probability and Bayes' theorem	U	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Implement R for creating scatter plots and performing statistical calculations.	Ap	P	Viva Voce/ Instructor-creat

				ed exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Unit 1: 2.1.3 Ref[1] Unit 2: 2.1.3 Ref[1] Unit 3: 2.1.3 Ref[1] Unit 4: 2.1.3 Ref[1]			
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	
	Unit 5: 10.1 Ref[2] Unit 6: 10.1Ref[2] Unit 7: 10.3 Ref[2] Unit 8:10.3.1 Ref[2] Unit 9: 10.7 Ref[2] Unit 10: 10.7.1 Ref[2] Unit 11:10.7.3 Ref[2]			
III		**Probability theory**	**10**	**25**
	12	Random experiment	1	
	13	Samplespace	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	
	Unit 12:4.5.1 Ref[2] Unit 13: 4.5.1 Ref[2] Unit 14: 4.5.2 Ref[2] Unit 15: 4.3.1 Ref[2] Unit 16: 4.3.2 Ref[2]			

	Unit 17: 4.5 Ref[2] Unit 18: 4.6.2 Ref[2]			
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	
	Unit 18: 4.7 Ref[2] Unit 19: 4.7 Ref[2] Unit 20: 4.7.3 Ref[2] Unit 21: 4.7.5 Ref[2] Unit 22: 4.8 Ref[2]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 6.2 Ref[3] Unit 2: 6.2 Ref[3] Unit 3: 6.3 Ref[3] Unit 4: 2.2 Ref[4] Unit 5: 2.3 Ref[4] Unit 6: 2.4 Ref[4] Unit 7: 2.5 Ref[4] Unit 8: 2.8 Ref[4]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	-	-	-	3	2	2	2	-	-	3
CO 2	2	-	1	-	-	2	2	2	3	-	3	-
CO 3	-	1	-	2	2	-	3	1	1	-	-	-
CO 4	3	-	-	-	-	-	1	2	2	-	-	-
CO 5	2	-	-	-	-	3	2	3	3	-	-	-
CO 6	-	-	2	-	-	2	2	2	2	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA3MN203 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Grasp random variables, distributions.	U	C	Instructor-created exams / Quiz
CO2	Summarize discrete, continuous distributions and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Calculate probabilities and statistical parameters for various standard distributions.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Introduce to statistical learning, variables, models and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Understand bagging, random forest.	Ap	P	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Implement classification, regression trees in R.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Unit 1: 5.1 Ref[2] Unit 2: 5.2 Ref[2] Unit 3: 5.3 Ref[2] Unit 4: 5.3.1 Ref[2] Unit 5: 5.3.2 Ref[2] Unit 6: 5.4 Ref[2] Unit 7: 5.4.1 Ref[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	
	Unit 8: 7.1 Ref[2] Unit 9: 7.2 Ref[2] Unit 10: 7.3 Ref[2] Unit 11: 8.2 Ref[2] Unit 12: 8.2.13 Ref[2]			
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	
	Unit 13: 2.1 Ref[1] Unit 14: 2.1 Ref[1] Unit 15: 2.1 Ref[1] Unit 16: 2.1.4 Ref[1] Unit 17:2.1.5 Ref[1] Unit 18: 8.1.1,8.1.2 Ref[1] Unit 19: 8.1.3 Ref[1] Unit 20: 8.1.4 Ref[1]			
IV	**Bagging**		**6**	**10**
	21	An introduction to Bagging	3	

	22	Random forest	3	
	Unit 21: 8.2.1 Ref[1] Unit 22: 8.2.2 Ref[1]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 8.3.1 Ref[1] Unit 2: 8.3.1 Ref[1] Unit 3: 3.6.2 Ref[1] Unit 4: 3.6.2 Ref[1] Unit 5: 3.6.2 Ref[1] Unit 6: 3.6.2 Ref[1] Unit 7: 3.6.2 Ref[1] Unit 8: 3.6.2 Ref[1]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	-	-	-	2	2	1	1	-	-	-
CO 2	2	2	-	3	2	2	2	1	2	-	3	-
CO 3	3	-	-	-	-	3	3	2	-	3	-	-
CO 4	2	-	-	-	-	2	2	3	1	-	-	3
CO 5	2	-	2	-	2	-	2	-	2	-	-	-
CO 6	-	-	-	2	-	2	1	2	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA1MN104 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand grouped and ungrouped data, scales of measurement, and questionnaire design and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Quiz
CO2	Comprehend statistical surveys, both census and sample, along with probability and nonprobability sampling methods.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Understand index numbers, emphasizing weighted aggregate index numbers and analyze data to help entrepreneurial decisions using critical thinking skills..	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Identify and describe key measures in vital statistics	U	C	Instructor-created exams / Home Assignments
CO5	Gain proficiency in time series analysis, including the measurement of secular trends and seasonal indices.	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Implement theoretical knowledge to practical scenarios through hands-on exercises using any software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive				

Knowledge (M)

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	
	Unit 1: 2.2 Ref[1] Unit 2: 2.3 Ref[1] Unit 3: 2.3 Ref[1] Unit 4: 2.3 Ref[1] Unit 5: 2.5 Ref[1] Unit 6: 3.3 Ref[1] Unit 7: 3.8 Ref[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]			

	Unit 2:12.2 Ref[2] Unit 3: 1 2.2.1 Ref[2] Unit 4: 12.2.2 Ref[2] Unit 5: 12.2.3 Ref[2] Unit 6: 12.2.4 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	
	Unit 7: 10.1&10.2[Ref 3] Unit 8: 10.3 [Ref 3] Unit 9: 10.4[Ref 3] Unit 10: 10.5 [Ref 3] Unit 11:10.6.2&10.6.3 [Ref 3] Unit 12: 16.2 [Ref 1] Unit 13:16.2&16.3 [Ref 1] Unit 14: 16.3&16.4[Ref 1] Unit 15: 16.5&16.6 [Ref 1] Unit 16:16.14,16.15,16.16,16.18 [Ref 1]			
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	
	Sections from References: Unit 17: 11.1& 11.3[Ref 3] Unit 18:11.2[Ref 3] Unit 19:.11.5[Ref 3] Unit 20: 11.5[Ref 3] .Unit 21: 11.5[Ref 3] Unit 22:11.6 [Ref 3]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 11.5 Ref[3] Unit 2: 11.5 Ref[3] Unit 3:11.6 Ref[3] Unit 4: 11.6 Ref[3] Unit 5: 4.16 Ref[1] Unit 6:4.19 Ref[1] Unit 7: 4.20 Ref[1] Unit 8: 4.21 Ref[1]			

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 PSOs and POs :

	PSO	PSO	PSO	PSO4	PSO	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

	1	2	3		5							
CO 1	2	1	-	-	-	1	1	1	2	-	-	3
CO 2	-	2	-	1	2	-	2	-	1	3	-	-
CO 3	-	-	3	-		-	2	1	-	-	3	-
CO 4	-	-	-	-	-	2	3	2	-	-	-	-
CO 5	-	-	2	-	2	3	-	3	-	3	-	-
CO 6	2	-	-	-	-	2	2	-	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA2MN104 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Grasp skewness and kurtosis measures, emphasizing Pearson's measure and percentile measure and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Quiz
CO2	Understand multiple regression concepts and the selection process and analyze data to help entrepreneurial decisions using critical thinking skills..	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Proficiently use JASP software for statistical analysis and result interpretation.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Comprehend sampling distributions and test statistics for Chi-square, F, and t distributions.	U	C	Instructor-created exams / Home Assignments
CO5	Implement theoretical knowledge in practical scenarios through hands-on exercises using JASP	Ap	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Illustrate how to draw scatter plot for correlation between variables.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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	
	Unit 1:3.13 Ref[2] Unit 2: 3.14 Ref[2] Unit 3: 3.13 Ref[2] Unit 4: 3.14 Ref[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	
	Unit 5: 9.9 Ref[1] Unit 6: 9.9 Ref[1] Unit 7: 9.10 Ref[1] Unit 8: 9.7 Ref[1] Unit 9: 9.2 Ref[1] Unit 10: 9.2 Ref[1] Unit 11: 9.6 Ref[1] Unit 12: 9.7Ref[1] Unit 13: 9.7 Ref[1] Unit 14: 9.8 Ref[1] Unit 15: 9.9 Ref[1]			
III	**JASPstatistical 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	
	Unit 16: 3.1 Ref[3] Unit 17: 3.3 Ref[3] Unit 18: 3.5 Ref[3] Unit 19: 4.1 Ref[3] Unit 20: 4.2 Ref[3]			
IV	**Sampling distributions**		**12**	**15**
	21	Chi-square distribution	4	
	22	Student’s t distribution	4	

	23	F distribution	4	
	Unit 21: 13.1 Ref[2] Unit 22: 14.2 Ref[2] Unit 23: 14.5 Ref[2]			
V	**PRACTICUM**		**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: Unit 1: 11.1.1 Ref[3] Unit 2: 11.1.3 Ref[3] Unit 3:11.1.5 Ref[3] Unit 4: 11.1.6 Ref[3] Unit 5: 11.2 Ref[3] Unit 6: 11.3 Ref[3] Unit 7:11.10 Ref[3] Unit 8:11.11 Ref[3]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	-	-	-	-	1	2	-	-	-	3
CO 2	-	-	2	-	-	2	2	2	-	-	3	-
CO 3	3	2	3	-	2	3	3	3	2	3	-	-
CO 4	3	3	-	-	-	3	3	2	1	-	-	-
CO 5	-	-	3	2	-	-	2	1	-	3	-	-
CO 6	2	1	-	-	-	2	2	2	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal	Assignm	Project	End Semester

	Exam	ent	Evaluation	Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA3MN204 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Grasp fundamentals of hypothesis testing, including null and alternative hypotheses, critical regions, and significance levels.	U	C	Instructor-created exams / Quiz
CO2	Understand small and large sample tests, focusing on tests for single mean and single proportion, t-tests, and chi-square tests.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Interpret results and understand the implications of large and small sample tests in real life situations and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Explain the fundamental purpose of one way ANOVA and its purpose in statistical analysis and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Gain an overview of support vector machines, hyperplanes, and classifiers.	U	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Implement theoretical knowledge to practical scenarios through hands-on	Ap	P	Viva Voce/ Instructor-creat

	exercises using R			ed exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Unit 1: 12.4 Ref[2] Unit 2:12.5 Ref[2] Unit 3:12.5.1 Ref[2] Unit 4: 12.6 Ref[2] Unit 5:12.7 Ref[2] Unit 6: 12.7.1 Ref[2]			
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	
	Unit 7:12.7.3 Ref[2] Unit 8: 14.2.9 Ref[2] Unit 9: 14.2.10 Ref[2]			

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	
	Unit 10: 13.7.2 Ref[2] Unit 11: 13.7.3 Ref[2] Unit 12: 5.5 Ref[1] Unit 13:5.6 Ref[1] Unit 14: 5.7 Ref[1] Unit 15:5.7 Ref[1]			
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	
	Unit 16: 9.1.1 Ref[3] Unit 17: 9.1.2 Ref[3] Unit 18: 9.1.3 Ref[3] Unit 19: 9.1.4 Ref[3] Unit 20: 9.1.5 Ref[3] Unit 21: 9.2.1 Ref[3] Unit 22: 9.3.2 Ref[3]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1:8.3.2 Ref[3] Unit 2: 8.3.3 Ref[3] Unit 3:9.1Ref[4] Unit 4: 9.2 Ref[4] Unit 5: 10.2 Ref[4] Unit 6:12.2 Ref[4] Unit 7:12.3 Ref[4] Unit 8:12.1 Ref[4]			

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 PSOs and POs :

	PSO	PSO	PSO	PSO4	PSO	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

	1	2	3		5							
CO 1	2	2	-	-	-	1	1	-	-	-	-	-
CO 2	-	2	-	2	-	3	-	-	2	-	-	-
CO 3	-	-	2	-	-	-	2	-	-	-	3	-
CO 4	2	-	-	-	-	2	-	2	-	-	-	2
CO 5	-	-	3	-	-	2	-	1	-	2	-	-
CO 6	-	-	2	-	-	3	-	-	-	2	3	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA1MN105 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand data types and sampling techniques and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Quiz
CO2	Master diagrammatic representation and frequency distribution	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Apply measures of central tendency with practical examples and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Grasp measures of dispersion and their applications	U	C	Instructor-created exams / Home Assignments
CO5	Conduct a survey and apply acquired skills using software	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Exlapin how to calculate measures of central tendency and dispersion using JASP software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 2.2 [Ref 2] Unit 2: 11.1 [Ref 2] Unit 3: 12.1 [Ref 1] Unit 4: 2.1 [Ref 2]			
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	
	Sections from References: Unit 5: 4.3(4.3.2 to 4.3.7) [Ref 2] Unit 6: 5.3 Ref[2] Unit 7: 3.3[Ref 2] Unit 8: 3.5 [Ref 2]			
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	
	Sections from References: Unit 9: 2.5,2.6,2.7 [Ref 1], Chapter 2 [Ref 3] Unit 10: 2.8,2.9 [Ref 1] Unit 11: 2.7 [Ref 1]			
IV	**Measures of dispersion**		**10**	**20**
	12	Range, Standard deviation,	4	
	13	Quartile deviation	4	
	14	Coefficient of variation	2	
	Sections from References: Unit 12: Section 1 and 4, Chapter 3 [Ref 3] Unit 13: Section 2, Chapter 3 [Ref 3] Unit 14: 3.8.1 [Ref 1]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 3.1 Ref[4] Unit 2: 3.3 Ref[4] Unit 3: 3.6 Ref[4] Unit 4: 4.1.2 Ref[4] Unit 5: 4.1.3 Ref[4] Unit 6: 4.1.6 Ref[4] Unit 7: 4.2.1 Ref[4] Unit 8: 4.2.2 Ref[4]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	2	3	2	-	-	-	3
CO 2	-	2	3	-	-	2	2	2	-	-	3	-
CO 3	3	-	2	-	3	3	3	2	2	3	-	-
CO 4	-	-	-	-	-	3	2	3	-	-	-	-
CO 5	2	-	-	-	-	-	2	1	-	-	-	2
CO 6	-	3	-	-	-	2	1	2	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓

CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN105 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Comprehend types of correlation and scatter diagrams and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Quiz/ Instructor-created exams
CO2	Understand properties of regression coefficients and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Introduce and apply probability theory concepts.	U	C	Seminar Presentation / Group Tutorial Work
CO4	Grasp the definition and types of	U	C	Instructor-crea

	random variables.			ted exams / Home Assignments
CO5	Develop critical thinking skills to interpret and communicate results of statistical analysis effectively.	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Describe how to draw scatter plot for correlation in JASP.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 10.1 Ref[2] Unit 2: 10.2 Ref[2] Unit 3: 10.3 Ref[2] Unit 4: 10.3.1 Ref[2] Unit 5: 10.3.2 Ref[2] Unit 6: 10.6 Ref[2]			

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	
	Sections from References: Unit 7: 10.7 Ref[2] Unit 8: 10.7.1 Ref[2] Unit 9: 10.7.3 Ref[2] Unit 10: 10.7.4 Ref[2] Unit 11: 10.7.4 Ref[2]			
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		

	Sections from References: Unit 12: 4.3 Ref[2] Unit 13: 4.3.1 Ref[2] Unit 14: 4.3.2 Ref[2] Unit 15: 4.5 Ref[2] Unit 16: 4.6.2 Ref[2] Unit 17: 4.7 Ref[2] Unit 18: 4.7.3 Ref[2]			
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	
	Sections from References: Unit 19: 5.1 Ref[2] Unit 20: 5.6 Ref[2] Unit 21: 5.4.1 Ref[2] Unit 22: 5.4 Ref[2]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 11.1.1 Ref[4] Unit 2: 11.1.3 Ref[4] Unit 3:11.1.5 Ref[4] Unit 4: 11.1.6 Ref[4] Unit 5: 11.2 Ref[4] Unit 6: 11.3 Ref[4] Unit 7:11.10 Ref[4] Unit 8:11.11 Ref[4]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	2	-	-	2	2	1	-	-	3	-

CO 2	2	-	-	-	-	-	1	2	-	-	-	3
CO 3	-	3	-	2	2	2	2	1	2	-	-	-
CO 4	3	2	-	-	-	3	3	2	-	-	-	-
CO 5	2	-	-	-	-	-	2	2	-	-	-	-
CO 6	2	2	3	-	-	3	3	2	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓

CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA3MN205 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand testing fundamentals and hypotheses.	U	C	Instructor-created exams / Quiz
CO2	Grasp test statistics and critical values.	U	C	Practical

				Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Apply t-tests and chi-square tests and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Ability to calculate probabilities using normal distribution.	U	C	Instructor-created exams / Home Assignments
CO5	Comprehend Analysis of Variance and critically evaluate ethical implications of statistical methods aligning with human values.(ANOVA)	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Conduct one sample tests in JASP software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	

	Sections from References: Unit 1: 12.4 Unit 2:12.5 Unit 3:12.5.1 Unit 4: 12.6 Unit 5:12.7 Unit 6: 12.7.1			
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	
	Sections from References: Unit 7:8.2.2 Ref[2] Unit 8: 8.2.2 Ref[2] Unit 9: 8.2.14 Ref[2] Unit 10: 8.2.14 Ref[2] Unit 11: 13.1 Ref[2] Unit 12: 14.2 Ref[2] Unit 13: 14.5 Ref[2]			

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	
	Sections from References: Unit 14:12.7.3 Ref[2] Unit 15: 14.2.9 Ref[2] Unit 16: 14.2.10 Ref[2] Unit 17: 13.7.2 Ref[2] Unit 18: 13.7.3 Ref[2]			
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	
	Sections from References: Unit 19: 5.5 Ref[1] Unit 20:5.6 Ref[1] Unit 21: 5.7 Ref[1] Unit 22:5.7 Ref[1]			

V	**PRACTICUM**		**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 t test		
	4	How ANOVA works in JASP		
	5	Running ANOVA in JASP		
	6	An illustrative data set		
	7	Assumptions of one way ANOVA		
	8	Continuity correction		
	Unit 1:9.1Ref[3] Unit 2: 9.2 Ref[3] Unit 3: 10.2 Ref[3] Unit 4:12.2 Ref[3] Unit 5:12.3 Ref[3] Unit 6:12.1 Ref[3] Unit 7: 12.6 Ref[3]			

	Unit 8: 9.3 Ref[3]		

Books and References:

1. S.P Gupta (2021), Statistical Methods 46 th Edition Gupta, S.C. and Kapoor, V.K. (1997)

2. 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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	2	-	-	-	2	2	2	-	-	-	-
CO 2	3	3	-	-	-	3	3	1	-	-	-	-
CO 3	-	-	2	-	-	2	2	2	-	-	3	-
CO 4	2	3	2	-	-	3	3	2	-	3	-	-
CO 5	-	2	-	2	3	-	2	2	1	-	-	3
CO 6	3	-	3	-	-	-	2	1	-	3	-	-

Correlation Levels:

Level	Correlation

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA1MN106 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand data collection methods and questionnaire types and critically evaluate ethical implications of statistical methods aligning with human	U	C	Instructor-created exams / Quiz

	values.			
CO2	Identify the differences between primary data and secondary data	U	C	Practical Assignment / Observation of Practical Skills
CO3	Assess scales of measurement, reliability, and validity and analyze data to help entrepreneurial decisions using critical thinking skills..	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Design survey questions that minimize bias and encourage accurate response.	U	C	Instructor-created exams / Home Assignments/ Instructor-created exams
CO5	Formulate and represent frequency distributions graphically.	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Master JASP software for descriptive statistics.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs (45+30)**	**Marks**
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	
	Unit 1: 2.2 Ref[1] Unit 2: 2.3 Ref[1] Unit 3: 2.3 Ref[1] Unit 4: 2.3 Ref[1] Unit 5: 2.5 Ref[1] Unit 6: 3.3 Ref[1] Unit 7: 3.8 Ref[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	
	Unit 6: 2.1 Ref[1] Unit 7: 2.2 Ref[1] Unit 8: 2.3 Ref[1] Unit 9:2.6 Ref[1]			
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	
	Unit 9: 2.2 Ref[2] Unit 10: 2.2.1 Ref[2] Unit 11: 2.2.2 Ref[2] Unit 12: 2.11.1 Ref[2] Unit 13: 6.40 Ref[1] Unit 14: 6.24 Ref[1] Unit 15: 6.24 Ref[1] Unit 16:: 6.29 Ref[1] Unit 17: 6.30 Ref[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	
	Sections from References: Unit 18: 3.1 Ref[3] Unit 19: 3.3 Ref[3] Unit 20: 3.5 Ref[3] Unit 21: 4.1 Ref[3] Unit 22: 4.2 Ref[3]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 4.5 Ref[3] Unit 2: 5.3 Ref[3] Unit 3: 5.1 Ref[3] Unit 4:5.2 Ref[3] Unit 5:5.2.2 Ref[3] Unit 6:2.2.1Ref[3] Unit7:2.2.2 Ref[3] Unit 8:2.2.3 Ref[3] Unit 9:2.2.4 Ref[3]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	3	-	-	-	2	1	2	-	-	-	3
CO 2	-	-	-	-	-	3	2	2	-	-	-	-
CO 3	-	2	-	3	2	-	2	2	2	-	3	-
CO 4	-	-	-	-	3	-	3	1	2	-	-	-
CO 5	3	-	-	-	-	-	2	2	-	-	-	-
CO 6	-	-	3	-	-	3	1	1	-	3	2	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN106 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Grasp skewness, kurtosis, and their measures.	U	C	Instructor-created exams / Quiz
CO2	Define correlation and distinguish between positive, negative and zero correlation and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Understand partial and multiple correlation and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Seminar Presentation / Group Tutorial/ Instructor-created exams Work
CO4	Describe and apply multiple linear regression to model relationship with more than one predictor variable.	U	C	Instructor-created exams / Home Assignments/ Instructor-created exams
CO5	Implement multiple regression techniques effectively.	U	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Introduce and apply R programming for	Ap	P	Viva Voce/

	statistical analysis.			Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Unit 1:3.13 Ref[2] Unit 2: 3.14 Ref[2] Unit 3: 3.13 Ref[2] Unit 4: 3.14 Ref[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	

	Unit 5: 9.2 Ref[1] Unit 6: 9.2 Ref[1] Unit 7: 9.6 Ref[1] Unit 8: 9.7Ref[1] Unit 9: 9.7 Ref[1] Unit 10: 9.8 Ref[1] Unit 11: 9.9 Ref[1]			
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	
	Unit 12: 9.9 Ref[1] Unit 13: 9.9 Ref[1] Unit 14: 9.10 Ref[1] Unit 15: 9.7 Ref[1]			
IV	**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	

	Unit 16: 1.1 Ref[3] Unit 17: 2.2 Ref[3] Unit 18:2.3 Ref[3] Unit 19: 3.3 Ref[3] Unit 20: 3.6 Ref[3] Unit 21: 4.2 Ref[3] Unit 22: 4.4 Ref[3]			
V	**PRACTIUM**		**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		
	Sections from References: Unit 1: 6.2 Ref[3] Unit 2: 4.3 Ref[3] Unit 3: 4.2 Ref[3] Unit 4: 1.5Ref[3] Unit 5: 1.2 Ref[3]			

	Unit 6: 1.6 Ref[3] Unit 7: 1.12 Ref[3] Unit 8: 1.9 Ref[3]		

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	3	1	2	-	2	2	-
CO 2	1	-	2	-	-	3	2	1	-	2	2	3
CO 3	-	-	2	-	-	2	2	2	-	1	3	-
CO 4	-	-	-	-	-	-	1	1	-	2	-	-
CO 5	-	3	-	2	2	-	3	2	2	2	-	-
CO 6	-	-	-	-	-	2	2	1	-	2	-	-

Correlation Levels:

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

	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA3MN206 (P)

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	Explain why sampling is used in statistical analysis.	U	C	Instructor-created exams / Quiz
CO 2	Describe and explain various sampling techniques such as simple random sampling, stratified sampling.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO 3	Introduce mediation and moderation analysis concepts .	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO 4	Define what non parametric tests are and explain how they differ from parametric tests and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Home Assignments
CO 5	Define correlation and explain its significance in statistical analysis and critically evaluate ethical implications of statistical methods aligning with human values.	R	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO 6	Apply JASP software for hypothesis testing and analysis.	Ap	P	Viva Voce/ Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	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	
	Sections from References: Unit 1: 12.1 Ref[2] Unit 2:12.2 Ref[2] Unit 3: 1 2.2.1 Ref[2] Unit 4: 12.2.2 Ref[2] Unit 5: 12.2.3 Ref[2] Unit 6: 12.2.4 Ref[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	
	Sections from References: Unit 7: 3.1 Ref[3] Unit 8: 3.2 Ref[3] Unit 9: 4.2 Ref[3] Unit 10: 7.1 Ref[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	
	Sections from References: Unit 11: 16.8 Ref[2] Unit 12 16.8.1 Ref[2] Unit 13:16.8.3 Ref[2] Unit 14: 16.8.5 Ref[2] Unit 15:16.8.7 Ref[2] Unit 16: 16.8.3 Ref[2]			
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	
	Sections from References: Unit 17: 10.1 Ref[4] Unit 18: 10.2 Ref[4] Unit 19: 10.3 Ref[4] Unit 20: 10.5 Ref[4] Unit 21:11.1 Ref[4] Unit 22: 11.2 Ref[4]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 10.8 Ref[4] Unit 2:10.9 Ref[4] Unit 3: 8.6 Ref[4]			

	Unit 4: 8.4 Ref[4] Unit 5: 8.5 Ref[4] Unit 6: 8.7 Ref[4] Unit 7: 7.1.1 Ref[4] Unit 8:7.1.2 Ref[4]		

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-	1	1	-	-	-	-
CO 2	-	-	-	-	-	3	2	1	-	-	-	-
CO 3	-	2	-	3	2	-	2	2	2	-	-	-
CO 4	-	-	3	-	-	3	3	3	2	-	3	-
CO 5	3	-	-	-	-	2	1	2	-	-	-	3
CO 6	-	-	3	-	-	-	2	3	-	3	-	-

Correlation Levels:

Lev	Correlation

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA1MN107 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate proficiency in collecting life science data and understanding the distinction between population and sample	U	C	Instructor-created exams / Quiz
CO2	Identify and analyze sampling and non-sampling errors, determine appropriate sample sizes, and recognize different variables and observational units within life science datasets.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Apply frequency distributions and plotting techniques to visualize life science data effectively and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Explore relationships between variables within life science datasets, employing statistical methods to quantify and analyze these relationships and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments/ Instructor-created exams
CO5	Define key terms in probability, including events, outcomes and sample spaces.	R	P	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Develop a basic understanding of how to do measures of central tendency and dispersion using spread sheet.	Ap	C	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

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	
	Sections from References: Unit 1: 1.1[Ref 1] Unit 2:2.2 [Ref 2] Unit 3: 15.2,15.3,15.6 [Ref 2] Unit 4: 15.6,15.7[Ref 2] Unit 5:15.11,15.11.1 [Ref 2] Unit 6: 15.12,15.12.1 [Ref 2] Unit 7: 15.13 [Ref 2] Unit 8:15.9.1[Ref 2]			
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	
	Sections from References: Unit 9: 3.3[Ref 2]			

	Unit 10: 3.5[Ref 2] Unit 11: 4.3[Ref 2] Unit 12: 4.4[Ref 2]			
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	
	Sections from References: Unit 13: 5.1&5.3[Ref 2] Unit 14: 5.4[Ref 2] Unit 15: 5.6[Ref 2] Unit 16: 5.7[Ref 2] Unit 17: 6.1,6.3&6.4[Ref 2] Unit 18: 6.5&6.6[Ref 2] Unit 19: 6.9[Ref 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	
	Sections from References: Unit 20: 12.3,12.5,12.6,12.7[Ref 2] Unit 21: 12.8[Ref 2] Unit 22: 12.9[Ref 2]			
5	**PRACTICUM**		**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		
	Sections from References: Unit 1: 1.2 Ref [5] Unit 2: 1.4 Ref [5] Unit 3: 2.1 Ref [5] Unit 4: 2.2 Ref [5] Unit 5: 2.3 Ref [5] Unit 6: 3.1 Ref [5] Unit 7: 3.2 Ref [5] Unit 8: 3.3 Ref [5]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	2	1	2	-	-	-	-
CO 2	-	-	-	-	-	2	2	2	-	-	-	-
CO 3	-	2	-	-	2	3	2	2	-	3	3	-
CO 4	-	-	3	-	-	2	2	1	-	-	-	3
CO 5	-	-	-	3	-	-	1	2	2	-	-	-
CO 6	-	-	3	-	-	-	3	2	1	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA2MN107 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop a basic understanding of Theoretical Distributions such as Binomial,Poisson and Normal distributions	U	C	Instructor-created exams / Quiz
CO2	Grasp the fundamental principles underlying sampling distributions.	R	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Analyze and interpret data effectively by comparing two means, calculating confidence intervals for the difference of two population means and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Evaluate the significance of differences between paired observations.	U	C	Instructor-created exams / Home Assignments
CO5	Explain the principles of relationships between categorical variables, including independence and association and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Demonstrate how to plot probability curves using any software.	Ap	P	Viva Voce/ Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

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	
	Sections from References: Unit 1:14.2 [Ref 1] Unit 2:14.3[Ref 1] Unit 3:14.4 [Ref 1]			
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	
	Sections from References: Unit 4: 16.6,16.6.1,16.6.3,16.6.4[Ref 1] Unit 5: 16.6.5,16.6.6,16.6.7[Ref 1] Unit 6: 16.6.8,16.6.9[Ref 1] Unit 7: 16.7[Ref 1] Unit 8: 17.2.1[Ref 1] Unit 9: 17.2.2[Ref 1] Unit 10: 17.3.1[Ref 1] Unit 11: 17.3.2[Ref 1]			
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	
	Sections from References: Unit 12: 18.2[Ref 1] Unit 13: 18.4&18.5[Ref 1] Unit 14: 18.6[Ref 1] Unit 15: 18.7[Ref 1] Unit 16: 18.8[Ref 1] Unit 17: 18.9[Ref 1]			
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	
	Sections from References: Unit 18: 19.2[Ref 1] Unit 19: 19.4[Ref 1] Unit 20: 19.5[Ref 1] Unit 21: 19.6[Ref 1] Unit 22: 19.7[Ref 1]			
V	**PRACTICUM**		**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 probability histogram		
	2	Finding mean and variance of a probability distribution		
	3	Methods for finding Binomial probability		
	4	Methods for finding Poisson probability		

	5	Find normal distribution areas		
	6	Find z scores from known area of normal probability		
	7	Assessing normality		
	8	Normal quantile plots		
	Sections from References: Unit 1: 5.1 [Ref 5] Unit 2: 5.1 [Ref 5] Unit 3: 5.2 [Ref 5] Unit 4: 5.4 [Ref 5] Unit 5: 6.1 [Ref 5] Unit 6: 6.1[Ref 5] Unit 7: 6.5[Ref 5] Unit 8: 6.5 [Ref 5]			

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, 12th 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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

CO 1	3	2	-	-	-	2	1	1	-	-	-	-
CO 2	-	-	-	-	-	3	2	2	-	-	-	-
CO 3	-	-	3	-	-	2	2	2	-	-	3	-
CO 4	-	2	-	-	-	-	2	3	-	-	-	-
CO 5	-	-	-	-	-	2	3	1	-	-	-	3
CO 6	-	2	-	2	3	-	2	2	3	3	-	2

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal	Assignm	Project	End Semester

	Exam	ent	Evaluation	Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA3MN207 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts and applications of inferential statistics and critically evaluate ethical implications of statistical methods aligning with human values .	U	C	Instructor-created exams / Quiz
CO2	Evaluate differences in means among multiple independent samples using one-way analysis of variance	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Define and understand the principles of non parametric statistics.	R	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Relate the fundamentals of linear regression and correlation and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Home Assignments
CO5	Explain what regression analysis is and how it differs from correlation analysis.	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Apply statistical techniques in software to analyze categorical data effectively	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

Module		Content	Hrs (45 +30)	Marks (70)
1		**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	
	Sections from References: Unit 1: 19.10,19.10.1,19.10.2[Ref 1] Unit 2:19.10.4[Ref 1] Unit 3: 23.1,23.2 [Ref 1] Unit 4: 23.3[Ref 1] Unit 5: 23.4[Ref 1]			
2		**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	
	Sections from References: Unit 5: 26.2[Ref 2] Unit 6: 26.2.1[Ref 2] Unit 7:26.3 [Ref 2] Unit 8: 26.4[Ref 2] Unit 9: 26.5 [Ref 2] Unit 10: 26.7[Ref 2]			

	Unit 11: 26.8[Ref 2] Unit 12: 26.9[Ref 2]			
3	**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	
	Sections from References: Unit 13: 8.1 [Ref 1] Unit 14: 8.1.1[Ref 1] Unit 15: 8.2[Ref 1] Unit 16: 8.3[Ref 1] Unit 17: 8.4[Ref 1]			
4	**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	
	Sections from References: Unit 18: 9.1 [Ref 1] Unit 19: 9.2[Ref 1] Unit 20: 9.3(9.3.1&9.3.2)[Ref 1] Unit 21: 9.4[Ref 1] Unit 22: 9.4.1,9.5,9.6[Ref 1]			
5	**PRACTICUM**		**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		
	Sections from References: Unit 1: 2.4 [Ref 5] Unit 2: 2.4 [Ref 5] Unit 3: 2.4 [Ref 5] Unit 4: 10.1 [Ref 5] Unit 5: 10.2 [Ref 5] Unit 6: 10.2 [Ref 5] Unit 7: 10.2 [Ref 5] Unit 8: 10.2 [Ref 5]			

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, 11^{th} edition, Sulthan Chand, New Delhi
5. Mario F Triola, Elementary Statistics using Excel

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

CO 1	3	2	-	-	-	2	1	2	-	-	-	3
CO 2	-	-	-	-	-	2	2	2	-	-	-	-
CO 3	-	-	-	-	3	-	2	1	-	-	-	-
CO 4	-	3	-	2	2	1	3	3	2	-	3	-
CO 5	-	-	-	-	-	2	2	2	-	-	-	-
CO 6	-	-	3	-	-	-	1	1	-	3	-	2

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal	Assignm	Project	End Semester

	Exam	ent	Evaluation	Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics
Course Code	STA1MN108 (P)
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify different types of variables, including categorical, ordinal, interval, and ratio variables, and analyze their characteristics.	U	C	Instructor-created exams / Quiz
CO2	Analyze relationships between variables, including correlations, associations, and causality and analyze data to help entrepreneurial decisions using critical thinking skills..	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Diffrentiate between qualitative and quantitative data	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Evaluate the advantages and disadvantages of four sampling methods: simple, stratified, cluster, and multistage sampling and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Calculate and interpret measures of dispersion, including range, variance, standard deviation, and coefficient of	U	C	One Minute Reflection Writing assignments/

	variation, to assess the spread or variability within a data set.			Instructor-created exams
CO6	Apply various methods for summarizing data, including numerical techniques such as scatter plots, dot plots, histograms, and box plots, and interpret their characteristics such as shape, symmetry, and outliers using R software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

COURSE CONTENT

Module	**Unit**	**Content**	**Hrs (45 +30)**	**Marks (70)**
1	**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]		
		Sampling principles and strategies	**11**	**15**
2	**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	
		Sections from References: Unit 5-7: 1.3 [Ref 2] Unit 8-9: 1.4 [Ref 2]		
		Summarizing data	**15**	**25**
3	**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	
		Sections from References: Unit 10-18: 2.1 [Ref 2]		
		Categorical data	**9**	**15**
4	**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	
		Sections from References: Unit 19-22: 2.2 [Ref 2]		
5	**PRACTICUM**		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		
	Sections from References: Unit 1: 1.3&1.4 [Ref 5] Unit 2: 1.5&1.6 [Ref 5] Unit 3: 1.8,2.3 [Ref 5] Unit 4: 2.2 [Ref 5] Unit 5: 2.4 [Ref 5] Unit 6: 2.4 [Ref 5] Unit 7: 2.5[Ref 5] Unit 8: 2.5[Ref 5]			
	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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-	2	2	-	-	-	-
CO 2	-	-	3	-	-	2	3	3	-	-	3	-
CO 3	-	2	-	3	1	-	2	2	2	-	-	-
CO 4	3	-	-	-	-	1	1	2	-	-	-	3
CO 5	-	-	3	-	-	2	3	2	2	3	-	-
CO 6	-	-	-	-	-	2	2	3	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓

CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN108 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Design and develop questionnaires and schedules, ensuring reliability and validity through appropriate measures and techniques and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Quiz
CO2	Evaluate the reliability of data through various techniques and analyze data to help entrepreneurial decisions using critical thinking skills..	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Utilize random variables to model outcomes of random experiment.	U	C	Seminar Presentation / Group Tutorial Work
CO4	Define probability and analyze scenarios involving disjoint or mutually exclusive outcomes using probability concepts and tools.	U	C	Instructor-created exams / Home Assignments/ Instructor-created exams
CO5	Identify and describe key properties of common statistical distributions.	Ap	P	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Explore various probability distributions such as Bernoulli, binomial, Poisson, geometric, and negative binomial distributions, including understanding their	Ap	P	Viva Voce/ Instructor-created exams

	characteristics and differences using R software.			

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

Module		Content	Hours (45 +30)	Marks (70)
		Methods of Data Collection	**9**	**10**
1	**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	
		Sections from References: Unit 1-3:		
		Probability	**11**	**20**
2	**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	
		Sections from References: Unit 4-9: 3.1,3.2 [Ref 2]		
		Continuous distributions	**14**	**20**
3	**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	
		Sections from References: Unit 10-15: 3.3,3.4,3.5 [Ref 2] Unit 16-17: 4.1 [Ref 2]		
		Discrete distributions	**11**	**20**
4	**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	
		Sections from References: Unit 18-22: 4.2,4.3,4.4,4.5 [Ref 2]		
5	**PRACTICUM**		**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 Probabilities from binomial distribution		
	6	Calculation of Probabilities from binomial distribution		
	7	Calculation of Probabilities from binomial distribution		

	8	Fitting of Binomial distribution		
	Sections from References: Unit 1: 3.3 [Ref 5] Unit 2: 3.3 [Ref 5] Unit 3: 3.3 [Ref 5] Unit 4:3.4&3.5 [Ref 5] Unit 5: 3.4 &3.5 [Ref 5] Unit 6: 3.4 &3.5 [Ref 5] Unit 7: 3.4 &3.5 [Ref 5] Unit 8: 3.4 &3.5 [Ref 5]			
	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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	2	-	-	-	3	1	2	-	-	-	3

1												
CO 2	-	-	3	-	-	2	2	1	-	-	3	-
CO 3	-	-	-	-	-	-	3	2	-	-	-	-
CO 4	-	3	-	3	2	-	2	2	3	-	-	-
CO 5	-	-	-	-	-	-	2	1	-	-	-	-
CO 6	-	-	3	-	-	2	1	2	-	3	-	2

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓	✓		✓

CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA3MN208 (P)				
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. Familiarity				

	with 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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the concept of a sampling distribution and calculate standard error for different statistics.	U	C	Instructor-created exams / Quiz
CO2	Explain central limit theorem and its importance in statistics.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Construct and interpret confidence intervals for proportions, including understanding the margin of error and changing the confidence level and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Analyze the difference of two proportions using hypothesis tests and confidence intervals.	U	C	Instructor-created exams / Home Assignments
CO5	Perform paired data analysis using paired t-tests and interpret the results and critically evaluate ethical implications of statistical methods aligning with human values.	U	f	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Conduct ANOVA tests to compare means across multiple groups and interpret ANOVA tables using R software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

Module		Content	Hours (45+ 30)	Marks (70)
		Statistical Inference	**12**	**17**
1	**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	
		Sections from References: Unit 1-7: 5.1,5.2,5.3 [Ref 2]		
		Hypothesis testing	**12**	**17**
2	**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	
		Sections from References: Unit 8-14: 6.1-6.4 [Ref 2]		
		Small sample tests	**14**	**19**
3	**15**	Inference for numerical data: One-sample means with the t-distribution, The sampling distribution of smaple 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	
		Sections from References: Unit 15-19: 7.1-7.5 [Ref 2]		
		Regression	**7**	**17**
4	**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	
		Sections from References: Unit 20-24:8.1-8.4 [Ref 2]		
5	**PRACTICUM**		**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		
	Sections from References: Unit 1: 4.5[Ref 5] Unit 2:4.5[Ref 5] Unit 3: 4.5[Ref 5] Unit 4: 4.5[Ref 5] Unit 5: 4.5[Ref 5] Unit 6: 5.2[Ref 5] Unit 7: 5.3[Ref 5] Unit 8: 5.4[Ref 5]			
	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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	-	-	2	-	-	-	3	-	-	-
CO 2	-	-	-	-	-	-	3	-	-	-	-	-
CO 3	2	2	-	-	-	-	1	-	-	-	3	-
CO 4	-	-	2	3	1	3	-	3	2	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	3
CO 6	-	-	3	-	-	2	-	-	-	3	3	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA1MN109 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Recognize the importance of statistical methods in geographical research and analysis.	U	C	Instructor-created exams / Quiz
CO2	Evaluate different types of data used in geography, including qualitative and quantitative variables, and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Calculate and interpret measures of central tendency, such as mean, median, and mode, and measures of dispersion, including range, variance, and standard deviation, in the context of geographical data analysis.	Ap	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Analyze higher-order moments or other numerical measures of the characteristics of distributions, such as skewness and kurtosis, and interpret their implications for spatial patterns and trends and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Introduce the concepts of correlation and regression analysis and their applications in geography, including assessing the strength and direction of relationships between variables and making predictions based on statistical models.	U	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Demonstrate measures of central	Ap	P	Viva Voce/ Instructor-creat

	tendency using spreadsheet.			ed exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

COURSE CONTENT

Module	Unit	Content	Hours (45 +30)	Marks (70)
1		**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: Validity, accuracy, precision	2	
	6	Data and Information	1	
	Sections from References: Unit 1: 1, 1.1 [Ref 1] Unit 2: 1.2 [Ref 1] Unit 3: 1.2 [Ref 1] Unit 4: 1.2 [Ref 1] Unit 5: 1.3 [Ref 1] Unit 6: 1.4 [Ref 1]			
2		**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	
	Sections from References: Unit 7: 3.1 [Ref 2] Unit 8: 3.2 [Ref 2] Unit 9: 3.3, 3.3.1, 3.3.2, 3.3.3, 3.3.4 [Ref 2] Unit 10: 3.4, 3.4.1, 3.4.2, 3.4.3, 3.4.4 [Ref 2] Unit 11: 3.5, 3.5.1, 3.5.2, 3.6 [Ref 2] Unit 12: 3.7, 3.7.2 [Ref 2]			
3	**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	
	Sections from References: Unit 13: 4.3.2, 4.3.3, 4.3.44.3.6, 4.3.7 [Ref 2] Unit 14: 4.4.2, 4.4.3, 4.4.4 [Ref 2] Unit 15: 4.5 [Ref 2] Unit 16: 5.4,5.6, 5.7, 5.8, 5.9, 5.10 [Ref 2] Unit 17: 5.12, 5.13 [Ref 2] Unit 18: 6.5, 6.6, 6.9 [Ref 2]			
4	**CORRELATION AND REGRESSION**		**10**	**15**
	19	Correlation	2	
	20	Correlation coefficient	2	

	21	Regression	3	
	22	Lines of regression	3	
	Sections from References: Unit 19: 8.1, 8.1.1, 8.1.2, 8.3 [Ref 2] Unit 20: 8.4 [Ref 2] Unit 21: 9.2 [Ref 2] Unit 22: 9.3, 9.3.1, 9.3.2, 9.3.4 [Ref 2]			
5	**PRACTICUM**		**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		
	Sections from References: Unit 1: 1.2 Ref [5] Unit 2: 1.4 Ref [5] Unit 3: 2.1 Ref [5] Unit 4: 2.2 Ref [5] Unit 5: 2.3 Ref [5] Unit 6: 3.1 Ref [5] Unit 7: 3.2 Ref [5] Unit 8: 3.3 Ref [5]			
	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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	-	3	-	-	-	-	-
CO 2	-	2	-	-	-	-	-	-	-	-	2	-
CO 3	-	-	-	-	-	3	-	3	-	-	-	-
CO 4	1	-	-	-	2	-	-	-	-	-	-	3
CO 5	-	2	3	1	-	-	-	-	2	1	-	-
CO 6	-	-	3	-	-	2	-	-	-	2	3	-

Correlation Levels:

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

	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN109 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define statistical experiments, sample spaces, and events, and recognize their significance in modeling uncertain outcomes.	U	C	Instructor-created exams / Quiz
CO2	Utilize conditional probability and understand the concept of statistical independence to analyze probabilistic relationships between events.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Define random variables and probability distributions, and analyze the distribution of discrete and continuous random variables, including calculating expectations and variances.	R	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Identify sampling biases and evaluate different types of non-probability sampling techniques, such as judgmental, convenience, quota, and volunteer sampling and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Home Assignments
CO5	Acquire a comprehensive knowledge of probability theory and its diverse applications in statistical experiments, random variables and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Solve practical problems involving probability distributions using	Ap	P	Viva Voce/ Instructor-created exams

	spreadsheet.			

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

Module	Units	Content	Hrs (45 +30)	Marks (70)
1		**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	
	Sections from References: Unit 1: 12.4 [Ref 1] Unit 2: 12.4.1 [Ref 1] Unit 3: 12.4.2 [Ref 1] Unit 4: 12.5, 12.6, 12.7 [Ref 1] Unit 5: 12.8 [Ref 1] Unit 6: 12.9 [Ref 1] Unit 7: 12.9.1, 12.9.2 [Ref 1] Unit 8: 12.10 [Ref 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	
	Sections from References: Unit 9: 13.1, 13.2, 13.3 [Ref 1] Unit 10: 13.4 [Ref 1] Unit 11: 13.5 [Ref 1] Unit 12: 13.6 [Ref 1] Unit 13: 13.8, 13.9 [Ref 1]			
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	
	Sections from References: Unit 14: 14.2, 14.2.1, 1.2.2, 1.2.3 [Ref 1] Unit 15: 14.3, 14.3.1, 14.3.2, 14.3.3 [Ref 1] Unit 16: 14.4, 14.4.1, 14.4.2 [Ref 1] Unit 17: 14.4.6, 14.4.7 [Ref 1]			
	SAMPLING		**11**	**15**
IV	**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	
	Sections from References: Unit 18: 15.6, 15.8[Ref 1] Unit 19: 15.10.1 [Ref 1] Unit 20: 15.11 [Ref 1]			

	Unit 21: 15.12 [Ref 1] Unit 22: 15.13 [Ref 1]			
5	**PRACTICUM**		**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		
	Sections from References: Unit 1: 5.1 [Ref 4] Unit 2: 5.1 [Ref 4] Unit 3: 5.1 [Ref 4] Unit 4: 5.2 [Ref 4] Unit 5: 5.3 [Ref 4] Unit 6: 6.1 [Ref 4] Unit 7: 6.1 [Ref 4] Unit 8: 6.1 [Ref 4]			
	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 :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	-	2	-	-	-	-	-
CO 2	-	-	-	-	2	-	-	-	3	-	-	-
CO 3	-	3	1	2	-	-	1	-	2	-	-	-
CO 4	-	-	2	-	-	2	-	-	-	-	3	-
CO 5	1	-	-	-	-	3	-	3	-	-	-	3
CO 6	-	-	3	-	-	-	-	-	-	2	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA3MN209 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define parameters and statistics, and differentiate between them using examples to illustrate their roles in statistical inference.	U	C	Instructor-created exams / Quiz
CO2	Explain what a sampling distribution is and differentiate it from a population distribution.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Describe the procedures for statistical estimation, including point estimation and interval estimation, and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Identify unbiased and efficient estimators and apply them to estimate population parameters such as the mean, proportion, and variance.	U	C	Instructor-created exams / Home Assignments
CO5	Interpret interval estimators for population mean and population proportion and critically evaluate ethical implications of statistical methods aligning with human values.	Ap	P	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Perform testing of hypothesis using any software.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

COURSE CONTENT

Mo	Units	Content	Hrs	Marks

dul e			(45 +30)	(70)
	SAMPLING THEORY		**10**	**10**
1	**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	
	Sections from References: Unit 1: 15.4 [Ref 1] Unit 2: 15.4.1, 15.4.2 [Ref 1] Unit 3: 15.5 [Ref 1] Unit 4: 16.3 [Ref 1] Unit 5: 16.3.2 [Ref 1]			
	THEORY OF ESTIMATION		**11**	**25**
2	**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	
	Sections from References: Unit 6: 16.2 [Ref 1] Unit 7: 16.2.1, 16.2.2, 1.62.3, 16.2.4, 16.2.5 [Ref 1] Unit 8: 16.4, 16.4.1, 16.4.2, 16.4.3 [Ref 1] Unit 9: 16.5 [Ref 1]			
3	**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	
	Sections from References: Unit 10: 16.6, 16.6.1, 16.6.3, 16.6.4 [Ref 1] Unit 11: 16.6.5, 16.6.6, 16.6.7 [Ref 1] Unit 12: 16.6.8 [Ref 1] Unit 13: 16.6.10 [Ref 1] Unit 14: 17 [Ref 1] Unit 15: 17.2.1 [Ref 1] Unit 16: 17.3.1 [Ref 1]			
	CHI SQUARE TEST		**12**	**15**
	17	Probability density function of Chi- square distribution	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	
4	**Sections from References:** Unit 17: 18.2.1 [Ref 1] Unit 18: 18.3 [Ref 1] Unit 19: 18.4 [Ref 1] Unit 20: 18.5 [Ref 1] Unit 21: 18.6 [Ref 1]			

	Unit 22: 18.7 [Ref 1]			
5	**PRACTICUM**		**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 :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	1	3	-	1	-	-	-	-
CO	-	-	-	-	-	-	-	-	-	-	2	-

3												
CO 4	1	-	–	-	-	3	-	-	-	-	-	3
CO 5	-	3	2	2	-	-	-	-	2	-	-	-
CO 6	-	-	3	-	-	3	-	-	-	2	3	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓

CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA1MN110 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and differentiate between primary data and secondary data, and understand the advantages and disadvantages of each type in research and analysis.	U	C	Instructor-created exams / Quiz
CO2	Classify data into quantitative and qualitative categories and recognize their characteristics and appropriate analysis techniques and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Construct frequency distributions for discrete and continuous variables, including cumulative frequency distributions, to summarize and organize data effectively and critically evaluate ethical implications of statistical methods aligning with human values.	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Calculate positional values such as quartiles, deciles, and percentiles, and interpret their significance in understanding the distribution of data.	Ap	C	Instructor-created exams / Home Assignments
CO5	Apply measures of dispersion to assess the consistency or variability of data points within a data set and make comparisons between different data sets.	Ap	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Apply spreadsheet functions to calculate measures of central tendency and dispersion.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 2.2-2.5 [Ref 3] Unit 2: 3.3 [Ref 3] Unit 3&4: 4.3-4.4 [Ref 3]			
II	**Measures of central tendency**		**9**	**15**
	5	Mean	2	
	6	Median, Mode	3	
	7	GM	2	
	8	HM	2	
	Sections from References: Unit 5: 2.5 [Ref 1] Unit 6: 2.6&2.7 [Ref 1] Unit 7: 2.8[Ref 1] Unit 8: 2.9[Ref 1]			
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	
	Sections from References: Unit 9,10&11: 2.10,2.11[Ref 1] Unit 12,13,14&15: 2.12,2.13[Ref 1] Unit 16&17: 2.14[Ref 1]			
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	
	Sections from References: Unit 18: 25-1.1,1.2,2 [Ref 2] Unit 19: 25-3.1,3.2,3.3[Ref 2] Unit 20: 25:4.1,4.3[Ref 2] Unit 21: 25:5.4[Ref 2] Unit 22: 25:5.1[Ref 2]			
V	**PRACTICUM**		**30**	
	1	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. Frequency distributions for organizing and summarizing data 3. Graphs of frequency distribution 4. Arithmetic mean 5. Median and Mode 6. Partition of values 7. Measure of dispersion 8. Different charts in quality control		
	Sections from References Unit 1: 1.2 Ref [4] Unit 2: 2.1 Ref [4] Unit 3: 2.2 Ref [4] Unit 4: 3.1 Ref [4] Unit 5: 3.2 Ref [4] Unit 6: 3.3 Ref [4] Unit 7: 3.4 Ref [4] Unit 8:2.2 Ref[4]			
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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	3	-	2	2	-	-	-	2	3	-
CO 3	-	-	-	-	-	-	2	-	-	-	-	3
CO 4	1	-	-	-	-	3	-	3	-	-	-	-
CO 5	-	3	2	2	-	-	-	-	3	-	-	-
CO 6							-	-	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN110 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define the components of a time series and distinguish between additive and multiplicative models, understanding their applications in time series analysis.	U	C	Instructor-created exams / Quiz
CO2	Explain the concept and significance of index numbers, and apply different types of simple and weighted index numbers to analyze changes in economic variables over time and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Construct scatter diagrams and analyze the strength and direction of relationships between variables using correlation analysis and critically evaluate ethical implications of statistical methods aligning with human values.	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Apply arithmetic and geometric sequences and series to analyze financial data, including calculations related to simple interest, compound interest, and annual percentage rates.	Ap	C	Instructor-created exams / Home Assignments
CO5	Calculate annuities and analyze debt repayment schedules, sinking funds, and other financial instruments.	Ap	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Explain the concept of correlation and use R to calculate correlation coefficients.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 19: 11.1&11.3 [Ref 1] Unit 20:11.2 [Ref 1] Unit 21&22:11.5 [Ref 1]			
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	
	Sections from References: Unit 5: 10.1,10.2,10.4[Ref 1] Unit 6: 10.3 [Ref 1] Unit 7&8: 10.5[Ref 1] Unit 8: 10.6.2,10.6.3 [Ref 1]			
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	
	Sections from References: Unit 9: 10.3 [Ref 2] Unit 10&11: 10.2 [Ref 2] Unit 12: 10.4 [Ref 2] Unit 13&14: 10.7[Ref 2] Unit 15: 11.1[Ref 2]			

	Unit 16&17: 11.2[Ref 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	
	Sections from References: Unit 19: 1.2&1.3 [Ref 3] Unit 20: 1.4 [Ref 3] Unit 21: 1.5&1.6 [Ref 3] Unit 22: 1.8,2.3 [Ref 3]			
V	**PRATICUM**		**30**	
	1	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		
	Sections from References: Unit 1: 1.8 Ref[3] Unit 2: 1.9 Ref[3] Unit 3: 2.1 Ref[3] Unit 4: 2.2 Ref[3] Unit 5:2.2 Ref[3] Unit 6: 2.3 Ref[3] Unit 7: 2.3 Ref[3] Unit 8: 2.3 Ref[3]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-	3	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	1	-	2	-
CO 3	-	-	2	-	-	-	-	-	-	-	-	3
CO 4	-	-	-	-	-	2	-	1	-	-	-	-
CO 5	-	2	-	1	3	-	-	-	1	-	-	-
CO 6	-	-	2	-	-	2	-	-	-	3	2	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA3MN210 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and apply basic concepts of probability, including classical probability and the axiomatic approach, to analyze uncertain events and outcomes.	U	C	Instructor-created exams / Quiz
CO2	Differentiate between census and sampling methods and recognize the advantages and limitations of each approach in data collection and critically evaluate ethical implications of statistical methods aligning with human values.	Ap	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Describe the principal steps involved in sample surveys, including the organization and execution of large sample surveys.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Define life tables and understand their construction, including calculating measures such as the force of mortality, and interpreting results in demographic analysis and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Home Assignments
CO5	Explain the concept of statistical quality control and differentiate between assignable causes and chance causes of variation in processes.	Ap	C	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Create basic plots in R to visualize range, variance and correlation between variables.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 3.3-3.8 [Ref 1] Unit 2: 3.9,3.11 [Ref 1] Unit 3: 3.10[Ref 1] Unit 4: 3.11-3.15 [Ref 1]			
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	
	Sections from References: Unit 5&6: 5.1-5.4.2 [Ref 1] Unit 7: 6.1-6.4 [Ref 1] Unit 8: 6.6 [Ref 1]			
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	
	Sections from References: Unit 9: 15.2,15.3,15.6 [Ref 1] Unit 10: 15.6,15.7[Ref 1] Unit 11: 15.8 [Ref 1] Unit 12: 15.9.1[Ref 1] Unit 13&14:15.10[Ref 1] Unit 15:15.11,15.11.1 [Ref 1] Unit 17: 15.12,15.12.1 [Ref 1] Unit 17: 15.13 [Ref 1]			

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	
	Sections from References: Unit 18&19: 2.1-2.3[Ref 3] Unit 20: 7.5 [Ref 2] Unit 21: 6.2 [Ref 2] Unit 22: 7.3 [Ref 2]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1,2: 2.1 [Ref 3] Unit 3: 2.2 [Ref 3] Unit 4,5: 2.3 [Ref 3] Unit 6,7,8: 6.2-7.5 [Ref 2]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6

CO 1	2	1	-	-	-	-	3	-	-	-	-	-
CO 2	-	-	1	-	-	2	-	-	-	-	-	3
CO 3	-	-	-	1	2	-	-	-	3	-	2	-
CO 4	-	-	-	-	-	2	-	1	2	-	-	-
CO 5	-	-	2	-	-	-	1	-	-	-	-	-
CO 6	-	-	3	-	-	2	-	-	-	2	1	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓

CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Differentiate between quantitative and qualitative data and identify suitable methods for their collection and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Quiz
CO2	Construct frequency distributions for both discrete and continuous variables.	U	c	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Calculate measures of central tendency including mean, median, mode, geometric mean, and harmonic mean and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Understand what dispersion means in the context of statistics and why it matters.	U	C	Instructor-created exams / Home Assignments
CO5	Apply positional values such as quartiles, deciles, and percentiles to analyze data distribution.	Ap	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Utilize R as a calculator, statistical software, and programming language for data analysis.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 2.2-2.5 [Ref 3] Unit 2: 3.3 [Ref 3] Unit 3&4: 4.3-4.4 [Ref 3]			
II	**Measures of central tendency**		**9**	**15**
	5	Mean	2	
	6	Median, Mode	3	
	7	GM	2	
	8	HM	2	
	Sections from References: Unit 5: 2.5 [Ref 1] Unit 6: 2.6&2.7 [Ref 1] Unit 7: 2.8[Ref 1] Unit 8: 2.9[Ref 1]			
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	
	Sections from References: Unit 9,10&11: 2.10,2.11[Ref 1] Unit 12,13,14&15: 2.12,2.13[Ref 1] Unit 16&17: 2.14[Ref 1]			
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	
	Sections from References: Unit 18&19: 1.2&1.3 [Ref 2] Unit 20: 1.4 [Ref 2] Unit 21: 1.5&1.6 [Ref 2] Unit 22: 1.8,2.3 [Ref 2]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1: 1.8 Ref[2] Unit 2: 1.9 Ref[2] Unit 3: 2.1 Ref[2] Unit 4: 2.2 Ref[2] Unit 5:2.2 Ref[2] Unit 6: 2.3 Ref[2] Unit 7: 2.3 Ref[2] Unit 8: 2.3 Ref[2]			
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 :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	-	-	-	2	-	-	-	-	-	2
CO 2	-	2	-	3	1	-	-	-	1	-	-	-
CO 3	-	-	2	-	-	1	-	-	2	-	3	-
CO 4	1	2	-	-	-	-	2	-	-	-	-	-

CO 5	-	-	-	-	-	2	-	3	-	-	-	-
CO 6	-	1	-	-	-	3	-	-	-	2	-	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA2MN111 (P)				
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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and calculate moments of a distribution and understand their significance in describing the shape and characteristics of data.	U	C	Instructor-created exams / Quiz
CO2	Fit various types of curves including straight lines, parabolas, and exponentials to data sets for modeling and prediction purposes and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Construct scatter diagrams and assess the strength and direction of relationships between variables using correlation and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Determine sample size requirements and assess sampling errors in the context of survey design and analysis.	U	C	Instructor-created exams / Home Assignments
CO5	Calculate correlation coefficient using R software and interpret their strength and direction.	Ap	P	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Implement R programming for computing and visualizing univariate and bivariate data using box plots, bar plots, pie diagrams, and scatter plots.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1:3.13 Ref[2] Unit 2: 3.14 Ref[2] Unit 3: 3.13 Ref[2] Unit 4: 3.14 Ref[2]			
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	
	Sections from References: Unit 5: 15.2-15.8 [Ref 2] Unit 6&7: 15.9-15.10[Ref 2] Unit 8: 15.11-15.13 [Ref 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	
	Sections from References: Unit 9: 10.3 [Ref 2] Unit 10&11: 10.2 [Ref 2] Unit 12: 10.4 [Ref 2] Unit 13&14: 10.7[Ref 2] Unit 15: 11.1[Ref 2] Unit 16&17: 11.2[Ref 2]			
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	

	Sections from References: Unit 18&19: 2.1-2.3[Ref 3] Unit 20: 7.5 [Ref 1] Unit 21: 6.2 [Ref 1] Unit 22: 7.3 [Ref 1]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1,2: 2.1 [Ref 3] Unit 3: 2.2 [Ref 3] Unit 4,5: 2.3 [Ref 3] Unit 6,7,8: 6.2-7.5 [Ref 2]			

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 :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	1	-	-	-	-	3	-	-	-	-	-

CO 2	2	-	-	-	-	-	-	-	-	2	2	-
CO 3	-	-	-	2	-	-	-	-	-	-	-	3
CO 4	-	-	-	-	-	3	-	2	-	-	-	-
CO 5	-	2	-	1	3	-	-	2	3	-	-	-
CO 6	-	-	2	-	-	2	-	-	-	3	2	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓

CO 5	✓	✓		✓
CO 6	✓			

Programme	BSc Statistics				
Course Code	STA3MN211 (P)				
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	CO Statement	Cognitive	Knowledge	Evaluation

		Level*	Category#	Tools used
CO1	Calculate probabilities of events using classical probability rules and understand their limitations.	U	C	Instructor-created exams / Quiz
CO2	Determine marginal probabilities and identify their role in joint probability distributions.	R	C	Practical Assignment / Observation of Practical Skills/ Instructor-created exams
CO3	Define random variables and distinguish between discrete and continuous random variables and analyze data to help entrepreneurial decisions using critical thinking skills.	R	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Understand the significance of probability distributions in statistical analysis and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Instructor-created exams / Home Assignments
CO5	Apply discrete and continuous probability distributions and understand their properties and applications.	Ap	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Perform computations involving probabilities and using R programming language.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: Unit 1: 3.3-3.8 [Ref 1] Unit 2: 3.9,3.11 [Ref 1] Unit 3: 3.10[Ref 1] Unit 4: 3.11-3.15 [Ref 1]			
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	
	Sections from References: 4. Unit 5&6: 5.1-5.4.2 [Ref 1] 5. Unit 7: 6.1-6.4 [Ref 1] 6. Unit 8: 6.6 [Ref 1]			
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	
	Sections from References: Unit 9:14.2 [Ref 2] Unit 10:14.3[Ref 2] Unit 11:14.4 [Ref 2] Unit 12:14.5 [Ref 2] Unit 13:14.6[Ref 2] Unit 14:14.7 [Ref 2] Unit 15:14.8 [Ref 2] Unit 16&17:14.9[Ref 2]			
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	
	Sections from References:			

	Unit 18: 3.3 [Ref 3] Unit 19: 3.3 [Ref 3] Unit 20: 3.3 [Ref 3] Unit 21:3.4&3.5 [Ref 3] Unit 22: 3.4 [Ref 3]			
V	**PRACTICUM**		**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		
	Sections from References: Unit 1,2: 3.3 [Ref 3] Unit 3,4,5: 3.4 [Ref 3] Unit 6,7,8: 3.5 [Ref 3]			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	2	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	1	-	-	1	-	1	-	-
CO 3	-	-	-	2	-	-	-	-	-	-	3	

CO 4	-	-	-	-	-	1	-	-	-	-	-	2
CO 5	-	3	-	1	-	-	-	-	2	-	-	-
CO 6	-	-	1	-	2	3	-	-	-	-	3	-

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓

CO 6	✓			

MINOR COURSES IN ACTUARIAL SCIENCE

SYLLABUS

Programme	BSc Statistics				
Course Code	ACT1MN101 (P)				
Course Title	Actuarial mathematics 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 knowledge of rates of interest, arithmetic skills, Basic computer skills				
Course Summary	The aim of this course is to provide a grounding in the principles of modelling as applied to actuarial work				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe how to use a generalized cash flow model in financial transaction.	U	F	Instructor-created exams / Quiz
CO2	Apply different kinds of interest rates	Ap	P	Instructor-creat

	expressed in different time periods			ed exams / Home Assignments
CO3	Recall and use the more important compound interest functions including annuities certain.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Describe how a loan may be repaid by regular instalments of interest and capital.	U	C	Instructor-created exams / Home Assignments
CO5	Recall how to take into account time value of money using the concepts of compound interest and discounting.	R	P	One Minute Reflection Writing assignments
CO6	Solving cash flow models with sample data with spread sheet	Ap	P	Viva-Voce/Practical Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**Cash flow models**		**8**	**10**
	1	Cash flow process, Examples of cash flow scenarios	2	
	2	A zero-coupon bond, A fixed interest security	2	
	3	An index-linked security, Cash on deposit	2	
	4	An equity, An “interest-only” loan, A repayment loan (or mortgage)	2	
	Sections from References: Unit 1: 3.1,3.2 [Ref 1] Unit 2: 3.2.1,3.2.2 [Ref 1] Unit 3: 3.2.3,3.2.4 [Ref 1] Unit 4: 3.2.5,3.2.7,3.2.8 [Ref 1]			
II	**The time value of money**		9	**15**
	5	Interest, Simple interest, Compound (effective) interest	2	
	6	Accumulation factors, The principle of	2	

		consistency, Present values		
	7	Discount rates, Simple discount, Compound (effective) discount, Discount factors, Effective rates of interest and discount	3	
	8	Equivalent rates	2	
	Sections from References: Unit 5: 4.1,4.1.1,4.1.2, [Ref 1] Unit 6: 4.1.3,4.1.4,4.2 [Ref 1] Unit 7: 4.3(4.3.1 to 4.3.3),4.4 - [Ref 1] Unit 8: 4.5- [Ref 1]			
III	**Interest Rates**		**12**	**25**
	9	Nominal rates of interest	2	
	10	Accumulating and discounting using nominal interest rates	2	
	11	Nominal rate of discount	2	
	12	Accumulating and discounting using nominal discount rates	2	
	13	The force of interest(Concept only)	1	
	14	Accumulating and discounting using the force of interest	2	
	15	Relationship between force of interest, effective rate of interest, effective rate of discount, and present value function, v.	1	
	Sections from References: Unit 9: 5.1,5.1.1([Ref 1] Unit 10: 5.1.2 [Ref 1] Unit 11: 5.1.3 [Ref 1] Unit 12: 5.1.4 [Ref 1] Unit 13: 5.2 [Ref 1] Unit 14: 5.2.2 [Ref 1] Unit 15: 5.2.2 [Ref 1]			
IV	**Level annuities and Equations of values**		16	**20**
	16	Present values, Payments made in arrear, Payments made in advance	2	
	17	Accumulations of annuities	2	
	18	Continuously payable annuities	3	
	19	Annuities payable pthly- Accumulations	2	
	20	Perpetuities, Perpetuities payable pthly, Deferred annuities	2	
	21	Equations of value, Solving for an unknown quantity	2	
	22	Solving for the timing of a payment (n), Solving	3	

		for the interest rate (i)		
	Sections from References: Unit 16: 8.1(8.1.1 to8.1.2) [Ref 1] Unit 17: 8.2 [Ref 1] Unit 18: 8.3[Ref 1] Unit 19: 8.4 (8.4.1 to 8.4.2) [Ref 1] Unit 20: 8.6,8.7,8.7.1[Ref 1] Unit 21: 10.1&10.1.2[Ref 1] Unit 22: 10.1.2 [Ref 1]			
V	**PRACTICUM**		**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	Simple interest and compound interest		
	2	Present value		
	3	Accumulated value		
	4	Force of interest		
	5	Annuities		
	6	Relationship between various interest rates		
	7	Perpetuity		
	8	Equations of values		

Books and References:

6. Institute of Actuaries Act Ed. Study materials CM1
7. McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
8. Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
9. David Promislow, S. (2014), Fundamentals of Actuarial Mathematics, John wiley& sons.
10. Newton LBowers, et al (1997):Actuarial Mathematics, The Societies of Actuaries, 2nd Ed
11. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	1	3	1	1	-	2	-	3	-	-	-
CO 2	3	3	1	2	1	-	3	1	2	1	-	-
CO 3	1	2	-	2	-	-	2	-	2	-	-	-
CO 4	3	2	-	1	-	-	3	-	2	2	-	-

CO 5	3	2	-	-	-	-	3	-	2	-	-	-
CO 6	1	1	2	-	3	3	2	2	1	-	2	2

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

Programme	BSc Statistics				
Course Code	ACT2MN101 (P)				
Course Title	Actuarial mathematics 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 of present value, probability, mean and variance, Basic computer skills				
Course Summary	The aim of this course is to expose the students about Life and Health Contingencies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To demonstrate the life table functions and select mortality.	An	C	Instructor-created exams / Quiz
CO2	To explain the life assurance contract and benefits.	U	C	Instructor-created exams / Home Assignments
CO3	Develop formulae for the means and	Ap	P	Seminar

	variances of the payments under various assurance and annuity contracts			Presentation / Group Tutorial Work
CO4	Define various annuity contracts.	U	C	Instructor-created exams / Home Assignments
CO5	Summarize various Joint life and last survivor functions	R	F	One Minute Reflection Writing assignments
CO6	Solving life and health contingencies with sample data with spread sheet	Ap	P	Viva-Voce/Practical Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**The life table**		**12**	**20**
	1	Life table, Constructing a life table	3	
	2	The force of mortality, Lifetime random variables, The pattern of human mortality	2	
	3	Life table functions at non-integer ages, uniform distribution of deaths (UDD), constant force of mortality (CFM)	4	
	4	Evaluating probabilities without use of the life table	1	
	5	Select mortality, Mortality rates that depend on both age and duration	2	
	Sections from References: Unit 1: 15.0&15.2 (15.2.1 to 15.2.2) [Ref 1] Unit 2: 15.2.3,15.2.6,15.2.7 [Ref 1] Unit 3: 15.3 (15.3.1 to 15.3.3) [Ref 1] Unit 4: 15.4 [Ref 1] Unit 5: 15.5,15.5.1, 15.5.2 [Ref 1]			
II	**Life assurance contracts**		**13**	**20**
	6	Whole life assurance contracts, Term assurance contracts	4	

	7	Pure endowment contracts, Endowment assurance contracts, Deferred assurance benefits	4	
	8	Benefits payable immediately on death (Whole life assurance, Term assurance, Endowment assurance)	3	
	9	Evaluating means and variances using select mortality.	2	
	Sections from References: Unit 6: 16.1 (16.1.1 to 16.1.3), 16.2 (16.2.1 to 16.2.3) [Ref 1] Unit 7: 16.3(16.3.1 to 16.3.3), 16.4 (16.4.1 to 16.4.3), 16.5(16.5.1, 16.5.2) [Ref 1] Unit 8: 16.6(16.6.1 to 16.6.4) - [Ref 1] Unit 9: 16.7- [Ref 1]			
III	**Life annuity contracts**		**11**	**15**
	10	Life annuity contracts, Whole life annuities payable annually in arrears	2	
	11	Whole life annuities payable annually in advance	1	
	12	Temporary annuities payable annually in arrears	1	
	13	Temporary annuities payable annually in advance	2	
	14	Deferred annuities, Deferred annuities-due	3	
	15	Continuous annuities , Other annuities	2	
	Sections from References: Unit 10: 17.1,17.2(17.2.1 to 17.2.3) [Ref 1] Unit 11: 17.3 (17.3.1 to 17.3.2) [Ref 1] Unit 12: 17.4 (17.4.1 to 17.4.2) [Ref 1] Unit 13: 17.5(17.5.1 to 17.5.2) [Ref 1] Unit 14: 17.6(17.6.1 to 17.6.2), 17.7 [Ref 1] Unit 15: 17.10,17.10.1, 17.10.2 [Ref 1]			
IV	**Joint life and last survivor functions**		9	**15**
	16	Random variables to describe joint life functions	1	
	17	Joint lifetime random variables and joint life table functions	2	
	18	Last survivor lifetime random variables	1	
	19	Simple probabilities involving two lives	1	
	20	Evaluating last survivor functions	1	
	21	Present values involving two lives	2	
	22	Present values of joint life and last survivor annuities	1	
	Sections from References: Unit 16: 22.1(22.1.1 to 22.1.2) [Ref 1] Unit 17: 22.1.3 [Ref 1]			

	Unit 18: 22.1.4[Ref 1] Unit 19: 22.2,22.2.1 [Ref 1] Unit 20: 22.2.2 [Ref 1] Unit 21: 22.3 & 22.3.1[Ref 1] Unit 22: 22.3.2 [Ref 1]		
V	**PRACTICUM**	**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 Life table using ultimate mortality		
	2 Select mortality		
	3 UDD and CFM assumption		
	4 Mean and variance of whole life assurance		
	5 Term assurance and endowment assurance		
	6 Life annuity contracts		
	7 Joint life functions		
	8 Last survivor functions		

Books and References:

1. Institute of Actuaries Act Ed. Study materials CM1
2. Dickson, Mary R. Hardy and Howard R.Waters (2019), Actuarial Mathematics for Life Contingent Risks , Cambridge University Press, India
3. McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
4. Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
5. David Promislow, S. (2014), Fundamentals of Actuarial Mathematics, John wiley& sons.
6. Newton LBowers, et al (1997):Actuarial Mathematics, The Societies of Actuaries, 2nd Ed
7. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	1	2	2	-	2	-	2	-	-	-
CO 2	3	3	1	2	1	-	3	1	2	3	-	-
CO 3	1	2	-	2	2	-	2	-	2	-	-	-
CO 4	3	2	1	1	-	-	3	-	2	2	-	-
CO	3	2	-	-	-	-	3	-	2	-	-	-

5												
CO 6	1	1	2	-	3	3	2	2	1	-	2	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

Programme	BSc Statistics				
Course Code	ACT3MN201 (P)				
Course Title	Risk modeling and survival analysis				
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 life table, probability, Basic computer skills				
Course Summary	The aim of this course is to provide a grounding in mathematical and statistical modelling techniques that are of particular relevance to actuarial work, including survival models and their application.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe and apply techniques of survival analysis	Ap	P	Instructor-created exams / Quiz
CO2	Describe Apply compound distributions in risk modelling.	Ap	P	Instructor-created exams / Home Assignments
CO3	Understand the concept of reinsurance	U	C	Seminar Presentation / Group Tutorial Work

CO4	Memorize the basic concepts of ruin theory.	R	C	Instructor-created exams / Home Assignments
CO5	Understand the basics of Machine Learning	U	F	One Minute Reflection Writing assignments
CO6	Solving survival models with sample data with spread sheet	Ap	P	Viva-Voce/Practical Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**Survival models-I**		**13**	**20**
	1	Survival models, Future lifetime, Probabilities of death and survival	3	
	2	The force of mortality, Survival probabilities	1	
	3	The probability density function of Tx, Life table functions, Initial and central rates of mortality	3	
	4	Expected future lifetime, Complete expectation of life, Curtate expectation of life, Some important formulae	3	
	5	Simple parametric survival models, The Gompertz and Makeham laws of mortality, Survival probabilities	3	
	Sections from References: Unit 1: 6.1 (6.1.1 to 6.1.2) [Ref 1] Unit 2: 6.1.3&6.1.4 [Ref 1] Unit 3: 6.1.5,6.1.6,6.1.7 [Ref 1] Unit 4: 6.2,6.2.1,6.2.2, 6.3 [Ref 1] Unit 5: 6.4, 6.5, 6.5.2 [Ref 1]			
II	**Risk Models- I**		**12**	**20**
	6	General features of a product, Models for short-term insurance contracts	2	
	7	The collective risk model, The basic model, Notation and assumptions	1	
	8	Distribution functions and convolutions	2	

	9	Moments of compound distributions, The compound Poisson distribution,	3	
	10	The compound binomial distribution	2	
	11	The compound negative binomial distribution	2	
	Sections from References: Unit 6: 19.1(19.1.1 to 19.1.2), 19.2 [Ref 1] Unit 7: 19.3, 19.3.1 [Ref 1] Unit 8: 19.3.2 [Ref 1] Unit 9: 19.3.3,19.3.4 [Ref 1] Unit 10: 19.3.5 [Ref 1] Unit 11: 19.3.6 [Ref 1]			
III	**Reinsurance & Risk Models- II**		**11**	**18**
	12	Reinsurance and its types	1	
	13	Reinsurance arrangements, Excess of loss reinsurance(concept only), proportional reinsurance (concept only)	2	
	14	The individual risk model	2	
	15	Ruin theory, Basic concepts	2	
	16	The surplus process	2	
	17	The probability of ruin in continuous & discrete time	2	
	Sections from References: Unit 12: 18.0 [Ref 1] Unit 13: 18.1,18.1.1,18.1.3 [Ref 1] Unit 14: 20.2 [Ref 1] Unit 15: 8.1 [Ref 2] Unit 16: 8.1.2 [Ref 2] Unit 17: 8.1.3 & 8.1.4 [Ref 2]			
IV	**Machine learning**		**9**	**12**
	18	What is machine learning?	1	
	19	An overview of machine learning	2	
	20	Concepts in machine learning- The loss function, Model evaluation, Generalisation error and model validation, Train- validation- test	2	
	21	Branches of machine learning	2	
	22	Stages of Analysing Machine learning	2	
	Sections from References: Unit 18: 21.1 [Ref 1] Unit 19: 21.2 [Ref 1] Unit 20: 21.3(21.3.1 to 21.3.4)[Ref 1] Unit 21: 21.4 [Ref 1] Unit 22: 21.5 (21.5.1 to 21.5.9)[Ref 1]			

V	**PRACTICUM**		**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	Survival probabilities		
	2	Expectation of life		
	3	Laws of mortality		
	4	Life table functions		
	5	Compound Poisson distribution		
	6	Compound binomial distribution		
	7	Distribution function		
	8	Surplus process		

Books and References:

1. Institute of Actuaries Act Ed. Study materials CS2.
2. Institute of Actuaries Act Ed. Study materials CT6.
3. Denuit,M., Marechal, X., Pitrebois, S., Walhin, J.F. (2007). Actuarial Modelling of claim counts: Risk classification, credibility and bonus-malus systems. John Wiley & Sons
4. Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed
5. Benjamin,B; Pollard, J.H. (1993).The analysis of mortality and other actuarial Statistics: (3rd Ed). Institute and faculty of Actuaries
6. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.
7. Daykin C.D, Pentikainen T. , Pesonen M.: Practical Risk theory for Actuaries (1194). Chapman& Hall.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	1	2	1	-	2	-	2	-	-	-
CO 2	3	3	2	2	1	-	3	1	2	3	-	-
CO 3	1	2	-	3	-	-	2	-	2	-	-	-
CO 4	3	2	-	2	1	-	3	-	2	2	-	-
CO 5	3	2	-	-	-	-	3	-	2	-	-	-
CO	1	1	2	-	3	3	2	2	1	-	2	2

6												

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

Programme	BSc Statistics				
Course Code	ACT1MN102 (P)				
Course Title	Financial Mathematics				
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 rates of interest, arithmetic skills, Basic computer skills				
Course Summary	The aim of this course is to provide a grounding in the principles of modelling as applied to actuarial work				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the possible aims of data analysis	U	F	Instructor-created exams / Quiz
CO2	Explain the meaning and value of reproducible research and describe the elements required to ensure a data analysis is reproducible.	U	P	Instructor-created exams / Home Assignments
CO3	Describe why and how models are used including, in general terms, the use of models for pricing, reserving and capital modelling.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Apply force of interest in various financial transaction.	An	C	Instructor-created exams / Home

				Assignments
CO5	Describe how a loan may be repaid by regular instalments of interest and capital.	Ap	P	One Minute Reflection Writing assignments
CO6	Solving cash flow models with sample data with spread sheet	Ap	P	Viva-Voce/Practical Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**Data Analysis**		**8**	**10**
	1	Aims of data analysis- Descriptive, inferential and predictive	2	
	2	The data analysis process	2	
	3	Data Sources, Big data	2	
	4	Data security privacy and regulation , Reproducible research	2	
	Sections from References: Unit 1: 1.1&1.1.1 to 1.1.3 [Ref 1] Unit 2: 1.2 [Ref 1] Unit 3: 1.3&1.3.1[Ref 1] Unit 4: 1.3.2&1.4 [Ref 1]			
II	**Principles of actuarial modelling**		**11**	**15**
	5	Model, How models are used, Modelling – the benefits and limitations	2	
	6	Stochastic and deterministic models, Discrete and continuous state spaces and time sets	2	
	7	Scenario-based and proxy models, Suitability of a model, Short-term and long-term properties of a model	3	
	8	Analysing the output of a model, Sensitivity testing, Communication of the results	2	
	9	Insurance contracts- Pure endowment, Endowment, term, contingent annuity, a car insurance policy, a health cash plan	2	

	Sections from References: Unit 5: 2.1,2.1.2 &2.2 [Ref 1] Unit 6: 2.3,2.4 [Ref 1] Unit 7: 2.5,2.6&2.7 [Ref 1] Unit 8: 2.8,2.9 & 2.10 [Ref 1] Unit 9: 3.1 (3.1.1 to 3.1.6) [Ref 1]			
III	**Real and Money interest rates**		**12**	**25**
	10	Real and Money interest rates	2	
	11	Deflationary conditions, Usefulness of real and money interest rates	2	
	12	Force of interest as a function of time	3	
	13	Relationship to constant force of interest, Applications of force of interest.	2	
	14	Present values of cash-flows	1	
	15	Payment streams, Sudden changes in interest rates	2	
	Sections from References: Unit 10: 6.1 ([Ref 1] Unit 11: 6.2 & 6.3[Ref 1] Unit 12: 5.4 [Ref 1] Unit 13: 5.4.2 [Ref 1] Unit 14: 7.1 [Ref 1] Unit 15: 7.2.2 & 7.2.3 [Ref 1]			
IV	**Loan Schedule & Varying annuities**		**14**	**20**
	16	Introduction, Calculating the capital outstanding	2	
	17	calculating the interest and capital elements	3	
	18	The loan schedule	1	
	19	Instalments payable more frequently than annually.	2	
	20	The consumer credit-APR	2	
	21	Varying annuities- Annual payments	3	
	22	Decreasing payments	1	
	Sections from References: Unit 16: 11.1&11.2 [Ref 1] Unit 17: 11.3 [Ref 1] Unit 18: 11.4[Ref 1] Unit 19: 11.5 [Ref 1] Unit 20: 11.6[Ref 1] Unit 21: 9.1.1[Ref 1] Unit 22: 9.1.3 [Ref 1]			
V	**PRACTICUM**		**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	Real and money interest rates		
	2	Present value of cash-flows		
	3	Payment streams		
	4	Relationship to constant force of interest		
	5	Loan schedule –preparation of loan amortization table		
	6	Loan schedule-Capital and interest calculations		
	7	APR		
	8	Flat rate of interest		

Books and References:

12. Institute of Actuaries Act Ed. *Study materials* CM1
13. McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
14. Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
15. David Promislow, S. (2014), Fundamentals of Actuarial Mathematics, John wiley& sons.
16. Newton LBowers, et al (1997):Actuarial Mathematics, The Societies of Actuaries, 2nd Ed
17. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	1	3	-	-	1	-	2	2	-	-
CO 2	3	2	-	2	1	-	3	1	2	3	-	-
CO 3	1	2	-	2	-	-	2	-	2	-	-	-
CO 4	3	2	-	1	-	-	3	-	2	2	-	-
CO 5	3	2	-	-	-	-	3	-	2	-	-	-
CO 6	1	1	2	-	3	3	2	2	1	-	2	1

Correlation Levels:

Lev	Correlation

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

Programme	BSc Statistics				
Course Code	ACT2MN102 (P)				
Course Title	Actuarial Economics				
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 of economic concepts				
Course Summary	The aim of this course is to provide the theoretical and practical understanding of the economic concepts and theories				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Assess the main strands of economic thinking.	An	P	Instructor-created exams / Quiz
CO2	Describe the factors that influence market demand and supply	U	F	Instructor-created exams / Home Assignments
CO3	Discuss how markets react to changes in demand and supply.	U	C	Seminar Presentation / Group Tutorial Work
CO4	Define and calculate price and income elasticities of demand and price elasticity of supply.	Ap	P	Instructor-created exams / Home Assignments
CO5	Remember the concept of marginal utility.	R	C	One Minute Reflection Writing assignments
CO6	Solving market economy with sample	Ap	P	Viva-Voce/Prac

	data with spread sheet			tical Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**Economic concepts and systems**		**10**	**15**
	1	What economists study, Problem of scarcity, Economic choices	2	
	2	Business economics, Introduction to microeconomics and Microeconomic, Production possibility curve	2	
	3	Main strands of economic thinking	2	
	4	The classical approach, Marxist socialism, Keynesian schools of thought: Neo-Keynesians, Post-Keynesians and New-Keynesians	2	
	5	The monetarist approach- The new classical approach, The Austrian School	2	
	Sections from References: Unit 1: 15.0&15.2 (15.2.1 to 15.2.2) [Ref 1] Unit 2: 15.2.3,15.2.6,15.2.7 [Ref 1] Unit 3: 15.3 (15.3.1 to 15.3.3) [Ref 1] Unit 4: 15.4 [Ref 1] Unit 5: 15.5,15.5.1, 15.5.2 [Ref 1]			
II	**Demand and Supply**		**13**	**20**
	6	Relationship between demand and price	4	
	7	The demand curve, Determinants of demand , Movements along and shifts in the demand curve	4	
	8	Supply: Supply and price, Supply curve , Determinants of supply, Movements along and shifts in the supply curve	3	
	9	Price and output determination: Equilibrium price and output, Movement to a new equilibrium, Incentives in markets	2	
	Sections from References: Unit 6: 16.1 (16.1.1 to 16.1.3), 16.2 (16.2.1 to 16.2.3) [Ref 1]			

	Unit 7: 16.3(16.3.1 to 16.3.3), 16.4 (16.4.1 to 16.4.3), 16.5(16.5.1, 16.5.2) [Ref 1] Unit 8: 16.6(16.6.1 to 16.6.4) - [Ref 1] Unit 9: 16.7- [Ref 1]			
III	**Elasticity and Uncertainty**		**11**	**20**
	10	Price elasticity of demand (PED)	2	
	11	measuring price elasticity of demand, Calculating PED using original and point method	1	
	12	Determinates of price elasticity of demand, Price elasticity of supply	1	
	13	Other elasticity: Income elasticity of demand, Cross-price elasticity of demand	2	
	14	The time dimension: Short- run and long-run adjustment, Price expectations and speculation, Dealing with uncertainty and risk, Control of prices	3	
	15	Indirect taxes and subsidies: Effect of imposing taxes, Effect of subsidizing goods	2	
	Sections from References: Unit 10: 17.1,17.2(17.2.1 to 17.2.3) [Ref 1] Unit 11: 17.3 (17.3.1 to 17.3.2) [Ref 1] Unit 12: 17.4 (17.4.1 to 17.4.2) [Ref 1] Unit 13: 17.5(17.5.1 to 17.5.2) [Ref 1] Unit 14: 17.6(17.6.1 to 17.6.2), 17.7 [Ref 1] Unit 15: 17.10,17.10.1, 17.10.2 [Ref 1]			
IV	**Consumer demand and uncertainty**		9	**15**
	16	Marginal utility theory	1	
	17	Timing of cost and benefits, indifference analysis	2	
	18	Demand under condition of risk and uncertainty	1	
	19	Utility and insurance	1	
	20	Behavioural economics	1	
	21	Prediction and cost, Meaning and types of costs	2	
	22	Production and cost in short run	1	
	Sections from References: Unit 16: 22.1(22.1.1 to 22.1.2) [Ref 1] Unit 17: 22.1.3 [Ref 1] Unit 18: 22.1.4[Ref 1] Unit 19: 22.2,22.2.1 [Ref 1] Unit 20: 22.2.2 [Ref 1] Unit 21: 22.3 & 22.3.1[Ref 1] Unit 22: 22.3.2 [Ref 1]			
V	**PRACTICUM**		**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	Demand and price		
	2	Price elasticity of demand (PED)		
	3	Price elasticity of supply		
	4	Marginal utility		
	5	Income elasticity of demand		
	6	Cross-price elasticity of demand		
	7	Calculating PED using original and point method		
	8	Equilibrium price and output		
	Sections from References: Unit 1: 1.2 Ref [5] Unit 2: 2.1 Ref [5] Unit 3: 2.2 Ref [5] Unit 4: 3.1 Ref [5] Unit 5: 3.2 Ref [5] Unit 6: 3.3 Ref [5] Unit 7: 3.4 Ref [5] Unit 8: 3.5 Ref [5]			

Books and References:

8. Institute of Actuaries Act Ed. Study materials CB2
9. Slomon J, Wride A, Garratt D, 2018-Economics –10th edition, Pearson.
10. Sloman J, Garratt D, Guest J, Jones E, 2016- Economics for Business –7th edition, Pearson
11. Parkin, M., & Bade, R. (2007). Foundations of economics. Pearson Addison Wesley.
12. Perman, R. J., & Scouller, J. (2010). Economics of corporate and competitive strategy Oxford University Press Autralia and New Zealand.
13. Chrystal, K. A., & Lipsey, R. G. (1997). Economics for business and management. OUP Catalogue.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	3	1	2	-	-	2	-	2	-	-	-
CO 2	3	3	-	2	1	-	3	1	2	3	-	-
CO 3	1	2	-	2	-	-	2	-	2	-	-	-
CO 4	3	2	-	1	-	-	3	-	2	2	-	-

CO 5	3	2	-	-	-	-	3	-	2	-	-	-
CO 6	1	1	2	-	3	3	2	2	1	-	3	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

Programme	BSc Statistics				
Course Code	ACT3MN202 (P)				
Course Title	Life Contingencies				
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 data, variables, charts and graphs, Basic computer skills				
Course Summary	The aim of this course is to provide a grounding in mathematical and statistical modelling techniques that are of particular relevance to actuarial work, including survival models and their application.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Calculate gross premium of assurance and annuity contracts using gross future loss random variable	Ap	P	Instructor-created exams / Quiz
CO2	Describe and calculate reserve under assurance and annuity contracts using prospective and retrospective method of valuation.	AP	P	Instructor-created exams / Home Assignments
CO3	Memorize the basic concepts of mortality profit.	R	C	Seminar Presentation / Group Tutorial Work
CO4	Define and calculate death strain at risk, expected death strain and actual death strain	An	P	Instructor-created exams / Home Assignments
CO5	Understand the basics of Multiple decrement model	U	F	One Minute Reflection Writing assignments

CO6	Analyse gross premium and reserve with sample data with spread sheet	Ap	P	Viva-Voce/Practical Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hours (45 +30)	Marks (70)
I	**Gross premiums**		**11**	**20**
	1	Gross premiums, Gross future loss random variable, Principle of equivalence	3	
	2	Determining gross premiums using the equivalence principle	2	
	3	Annual premium contracts	2	
	4	Premiums payable m times per year	2	
	5	Calculating gross premiums using simple criteria other than the equivalence principle	2	
	Sections from References: Unit 1: 20.1, 20.2 &20.3 [Ref 1] Unit 2: 20.3.2 [Ref 1] Unit 3: 20.3.5 [Ref 1] Unit 4: 20.3.7 [Ref 1] Unit 5: 20.4 [Ref 1]			
II	**Gross premium reserves**		13	**20**
	6	Gross premium reserves, Why hold reserves	2	
	7	Prospective reserves, Calculating gross premium prospective reserves,	3	
	8	Calculating prospective reserves that satisfy probabilities	2	
	9	Retrospective reserves, Retrospective accumulations, Gross premium retrospective reserve	2	
	10	Equality of prospective and retrospective reserves	2	
	11	Net premium reserves for conventional without profit contracts.	2	
	Sections from References: Unit 6: 21.0 &21.1 [Ref 1]			

	Unit 7: 21.2&21.2.1 [Ref 1] Unit 8: 21.2.2 [Ref 1] Unit 9: 21.3,21.3.1, 21.3.2 [Ref 1] Unit 10: 21.4 [Ref 1] Unit 11: 21.6 [Ref 1]			
III	**Mortality profit**		**12**	**15**
	12	Mortality profit on a single policy	2	
	13	Mortality profit on a portfolio of policies	2	
	14	Allowing for death benefits payable immediately	2	
	15	Allowing for survival benefits annuities	2	
	16	Allowing for different premium or annuity payment frequencies	1	
	17	Calculation of mortality profit for policies involving two lives.	3	
	Sections from References: Unit 12: 24.1(24.1.1 to 24.1.4) [Ref 1] Unit 13: 24.2 [Ref 1] Unit 14: 24.3 [Ref 1] Unit 15: 24.4 [Ref 1] Unit 16: 24.5 [Ref 1] Unit 17: 24.6 [Ref 1]			
IV	**Competing risks**		**9**	**15**
	18	Health insurance contracts	1	
	19	Multiple state models	2	
	20	Valuing continuous cash-flows using multiple state models	2	
	21	Designing the multiple state model	2	
	22	Multiple decrement models, Multiple decrement tables	2	
	Sections from References: Unit 18: 25.1 [Ref 1] Unit 19: 25.2 [Ref 1] Unit 20:25.2.2[Ref 1] Unit 21: 25.2.3 [Ref 1] Unit 22: 25.3&25.4[Ref 1]			
V	**PRACTICUM**		**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	Gross future loss random variable		

	2	Gross premium- Whole life		
	3	Gross premium- endowment		
	4	Annual premium contracts		
	5	Gross premium reserve		
	6	Prospective and retrospective reserve		
	7	Mortality profit		
	8	Multiple decrement tables		

Books and References:

8. Institute of Actuaries Act Ed. Study materials CM1.
9. Neill, Alistair, Heinemann, (1977): *Life contingencies.*
10. Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed
11. Jones, H.E & Long, D.L (2005): Principles of Insurance: Life, Health and annuities. LOMA
12. Dickson, D.C.M; Hardy M.R; Waters, H.R.-Actuarial Mathematics for life contingent risks: 2nd ed. Cambridge University Press (2013)
13. Neill, Alistair, Heinemann, (1977): *Life contingencies.*
14. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	2	2	2	-	-	2	1	2	-	-	-
CO 2	3	3	-	2	1	-	3	1	2	2	-	-
CO 3	1	2	-	2	-	-	2	-	2	-	-	-
CO 4	3	2	2	1	-	-	3	-	2	3	-	-
CO 5	3	2	-	-	-	-	3	-	2	-	-	-
CO 6	1	2	2	-	3	3	2	2	1	-	2	1

Correlation Levels:

Lev	Correlation

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

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain notion of Quality of products	U	C	Instructor-created exams / Quiz
CO2	Recall various meaning of Quality and critically evaluate ethical implications of statistical methods aligning with human values.	R	C	Quiz / Instructor-created exams
CO3	Explain causes of variation and Statistical Control and analyze data to help entrepreneurial decisions using critical thinking skills	U	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Construction of Control Charts and OC curves	Ap	C	Instructor-created exams / Home Assignments
CO5	Distinguish Process and Product Control	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Illustrate measures of central tendency using spread sheet.	Ap	P	Viva Voce/ Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

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		
	Sections from References:			
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		
	Sections from References:			
III	**Construction of Charts**		**9**	**10**
	9	Construction of $\bar{X}$ (mean) 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.		
	Sections from References:			
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		
	Sections from References:			
V	**Open Ended Module: Spread sheet**		**9**	
	1	Exercises to compute Arithmetic Mean, Range, Standard Deviation for a set of data, Basic concepts of Probability		
	Sections from References:			
Books and References:				

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	-	-	-	2	2	1	-	-	-	-
CO 2	2	-	-	-	-	3	2	2	-	-	-	3
CO 3	-	-	3	-	-	2	1	-			3	
CO 4	-	-	2	2	-	-	2		2	3		
CO 5	-	-	2	2	2	-	2	3	2	-	-	-
CO 6	3	2	-	-	-	2	3	-	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

18. Quiz / Assignment/ Quiz/ Discussion / Seminar
19. Midterm Exam
20. Programming Assignments (20%)
21. Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define statistics and its scope in various fields of study, including its role in decision-making.	U	C	Instructor-created exams / Quiz
CO2	Construct tables and diagrams to organize and summarize data efficiently for analysis and analyze data to help entrepreneurial decisions using critical thinking skills.	Ap	C	Instructor-created exams / Seminar Presentation
CO3	Create various types of diagrams such as bar graphs, pie charts, and histograms for visual representation of data and critically evaluate ethical implications of statistical methods aligning with human values.	Ap	F	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Compute measures of central tendency including mean, median, and mode to identify typical or central values within a data set.	Ap	C	Instructor-created exams / Home Assignments
CO5	Interpret partition values such as quartiles and percentiles to identify specific data points within a distribution.	U	F	One Minute Reflection Writing assignments/ Instructor-creat

				ed exams
CO6	Illustrate measures of central tendency and dispersion using spread sheet.	Ap	P	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

COURSE CONTENT

Module		**Content**	**Hours (36+9)**	**Marks (50)**
1	**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	
	Sections from References: Unit 1: 1.1&1.2 [Ref 1] Unit 2: 1.3 [Ref 1] Unit 3: 1.3 [Ref 2] Unit 4: 1.4 [Ref 2]			
2	**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	
	Sections from References: Unit 5: 2.1 [Ref 2] Unit 6: 2.1 [Ref 1] Unit 7: 2.1[Ref 1] Unit 8: 2.3[Ref 2] Unit 9: 2.2 [Ref 1 and 2]			
3	**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	
	Sections from References: Unit 10: 2.3, 2.4 & 2.5 [Ref 1] Unit 11: 2.8 [Ref 1] Unit 12: 2.9[Ref 1] Unit 13: 2.6 & 2.7[Ref 1] Unit 14: 3.1 [Ref 1] Unit 15: 3.4,3.5,3.6, & 3.7 [Ref 1]			
4	**Skewness & Kurtosis**		**5**	**10**
	16	Partition values	3	
	17	Skewness	1	
	18	Kurtosis	1	
	Sections from References: Unit 16: 2.11 [Ref 1] Unit 17: 3.13 [Ref 1] Unit 18: 3.14[Ref 1]			
5	**Open ended: practical problems Using Spreadsheet**		**9**	
	1	Frequency distributions for organizing and summarizing data	3	
	2	Measures of Central Tendency	3	
	3	Measures of Dispersion	3	
	Sections from References: Unit 1: 2.1Ref [3] Unit 2: 2.2 Ref [3] Unit 3: 3.2 Ref [3]			
	Books and References: ▪ Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi. ▪ Prem. S. Mann (2010). Introductory Statistics, 7th edition, Wiley ▪ Mario F Triola, Elementary Statistics using Excel, (2018), 6th edition.			

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	-	-	1	-	2	-	2	1	-	-	-	-
CO 2	2	2	-	-	-	2	2	2	-	-	-	3
CO 3	-	-	3	-	-	-	1	-	-	-	3	-
CO 4	2	2	3	-	3	2	2	-	2	3	-	-
CO 5	-	2	-	2	2	3	2	3	2	-	-	-
CO 6	3	2	-	-	-	3	3	-	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

6. Quiz / Assignment/ Quiz/ Discussion / Seminar
7. Midterm Exam
8. Programming Assignments (20%)
9. Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain various decision making environments in management	U	C	Instructor-created exams / Quiz/ Seminar presentation
CO2	Discuss the outcome of any payoff	R	F	Practical Assignment / Instructor-created exams
CO3	Assessing the purpose of Inventory for smooth Business operations and critically evaluate ethical implications of statistical methods aligning with human values.	U	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Explain the simulation of a real system	U	C	Instructor-created exams / Home Assignments
CO5	Describe the role of game theory in business and analyze data to help entrepreneurial decisions using critical thinking skills	U	F	One Minute Reflection Writing assignments/ Instructor-created exams
CO6	Define probability and discuss expected values.	R	F	Viva Voce/ Instructor-created exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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		
	Sections from References:			
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		
	Sections from References:			
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		
	Sections from References:			
IV	**Solving games**		**9**	
	15	Minmax and Maxmin Criterions		
	16	Saddle Point and solution		
	17	Principle of Dominance		
	18	Solving 2x2 games		
	19	Graphical solution of 2xn and nx2 games		
	Sections from References:			
V	**Open Ended Module**		**9**	
	1	Basics of Matrices, Scalar and Vector multiplication, Concepts of Probability and Expected Value of Variables		
	Sections from References:			
Books and References:				

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	2	2	3	3	-	3	-	2	2
CO 2	3	-	-	-	-	-	2	-	-	-	-	2
CO 3	-	-	2	-	-	2	2	2	-	-	3	-
CO 4	-	-	3	-	-	2	2	2	-	-	3	3
CO 5	-	-	3	-	-	2	1	-	-	2	3	2
CO 6	3	2	-	-	-	3	3	3	-	-	-	-

Correlation Levels:

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

Assessment Rubrics:

6. Quiz / Assignment/ Quiz/ Discussion / Seminar
7. Midterm Exam
8. Programming Assignments (20%)
9. Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define and differentiate between data, variables, and attributes, and understand their role in statistical analysis.	U	C	Instructor-created exams / Quiz
CO2	Demonstrate proficiency in preparing questionnaires for data collection, considering factors such as clarity, relevance, and reliability and critically evaluate ethical implications of statistical methods aligning with human values..	U	F	Seminar Presentation / Instructor-created exams
CO3	Identify and describe different types of sampling methods, including simple random sampling, stratified random sampling, systematic sampling, and cluster sampling and analyze data to help entrepreneurial decisions using critical thinking skills.	R	C	Seminar Presentation / Group Tutorial Work/ Instructor-created exams
CO4	Define random experiment, sample space, and event, and understand their relevance in probability theory.	U	C	Instructor-created exams / Home Assignments
CO5	Define probability and understand its interpretation as a measure of uncertainty.	U	F	One Minute Reflection Writing assignments/ I

				nstructor-created exams
CO6	Represent how to list different types of data using any software	Ap	P	Viva Voce/ Instructor-created exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

COURSE CONTENT

Module		**Content**	**Hours (36+9)**	**Marks (50)**
	Basic Statistics		**10**	**10**
1	**1**	Data	2	
	2	Variables and Attributes	2	
	3	Definition of Population and Sample	3	
	4	Preparation of questionnaire for data collection	3	
	Sections from References: Unit 1: 2.1 [Ref 2] Unit 2: 1.5[Ref 2] Unit 3: 1.3 [Ref 2] Unit 4: 1 [Ref 2]			
	Census and Sampling		**6**	**10**
2	**5**	Census and Sampling	2	
	6	Principal steps in a sample survey	2	
	7	Types of sampling	1	
	8	Sampling methods	1	
	Sections from References: Unit 5: 15.2,15.3,15.6 [Ref 3] Unit 6: 15.8 [Ref 3] Unit 7:15.10[Ref 3] Unit 8:15.10[Ref 3]			
	Random Sampling Methods		**9**	**15**
3	**9**	simple random sampling with and without replacement	5	

	10	Stratified random sampling (concept only)	2	
	11	Systematic Sampling (concept only)	1	
	12	Cluster sampling (concept only)	1	
	Sections from References: Unit 9:15.11,15.11.1 [Ref 3] Unit 10: 15.12,15.12.1 [Ref 3] Unit 11: 15.13 [Ref 3] Unit 12:A2 [Ref 2]			
	Introduction to Probability		**11**	**15**
4	**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	
	Sections from References: Unit 13: 4.5.1 Ref [1] Unit 14: 4.5.1 Ref [1] Unit 15: 4.5.2 Ref [1] Unit 16: 4.5 Ref [1] Unit 17: 4.6 Ref [1] Unit 18: 4.6 Ref [1]			
5	**Open ended - Practical problems using softwares**		**9**	
	1	Data collection	**3**	
	2	Sample selection	**3**	
	3	Probability	**3**	
	Books and References: 6. Gupta, S. C. and Kapoor, V. K. (2002). Fundamentals of Mathematical Statistics. **,** 11th edition, Sulthan Chand, New Delhi. 7. Prem. S. Mann (2010). Introductory Statistics, 7th edition, Wiley **8.** Gupta, S. C. (2015). Fundamentals of Statistics, Himalaya Publishing House			

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	3	3	3	-	-	-	-
CO 2	2	2	-	-	-	2	2	2	-	-	-	3
CO 3	-	2	3	2	2	3	1	3	2	3	3	-
CO 4	3	2	-	-	-	3	3	3	-	-	-	-
CO 5	-	-	-	-	-	3	2	3	-	-	-	-
CO 6	-	-	3	-	-	-	2	2	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

10. Quiz / Assignment/ Quiz/ Discussion / Seminar
11. Midterm Exam
12. Programming Assignments (20%)
13. Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

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	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the basics of Python programming language and its syntax.	U	F	Instructor-created exams / Quiz
CO2	Identify common types of errors and their underlying causes such as incorrect syntax, invalid variable assignments, and type mismatches.	R	C	Instructor-created exams / Home Assignments/ Seminar Presentation
CO3	Describe the funda mental data structures in Pandas and their rol e in data manipulation and analyze data to help entrepreneurial decisions using critical thinking skills.	U	F	Instructor-created exams / Home Assignments/ Seminar Presentation
CO4	Familiarize themselves with popular data visualization libraries in Python and critically evaluate ethical implications of statistical methods aligning with human values.	R	C	Instructor-created exams / Quiz
CO5	Discuss the importance of random number generation in computational simulations	U	F	Instructor-created exams / Quiz/

	and statistical analysis.			Viva-Voce
CO6	Apply the basic concepts and principles of machine learning.	Ap	P	Instructor-created exams / Home Assignments/ Seminar Presentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

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	
	Sections from References: 2, 3, 5, 6			
II	**Data Manipulation with Pandas**		**10**	
	5	Pandas Introduction: Data Series, DataFrames	4	
	6	Data Operations: Importing, manipulating, merging, analyzing, and exporting DataFrames	4	
	7	Descriptive Statistics: Exploratory data analysis techniques	2	
	Sections from References: 1, 3, 7, 11			
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	
	Sections from References: 1, 4, 9, 10			
IV	**Statistical Data Analysis Using statsmodels**		**18**	
	18	Random Number Generation	3	

	19	Correlation	2	
	20	Hypothesis Testing -I: One sample, two sample and paired t test	2	
	21	Hypothesis Testing -II: One way and Two way ANOVA	3	
	22	Hypothesis Testing -III: Non Parametric Tests	3	
		Linear Regression Modeling: Simple and multiple linear regression	3	
		Logistic Regression Models	2	
	Sections from References: 4, 9,10,11			
V	**Open Ended Module:**		**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	
	Sections from References: 7, 9, 11			

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 PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	3	3	-	-	-	-	-
CO 2	3	2	-	-	-	3	3	-	-	-	-	-
CO 3	-	-	2	-	-	2	1	-	-	3	3	-
CO 4	2	-	2	-	-	-	2	-	-	3	-	2
CO 5	-	-	2	1	2	-	2	-	1	3	-	-
CO 6	2	2	-	-	-	2	3	-	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

5. Quiz / Assignment/ Quiz/ Discussion / Seminar
6. Midterm Exam
7. Programming Assignments (20%)
8. Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓			

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.				

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify gaps, contradictions and areas for further exploration within the existing body of literature.	R	F	Instructor-created exams / Quiz
CO2	Ethically and accurately cite article references in accordance with academic integrity standards.	U	C	Instructor-created exams / Home Assignments
CO3	Develop a coherent and logically structured thesis report that adheres to academic conventions and standards.	R	P	Seminar Presentation / Group Tutorial Work
CO4	Construct text, equations, figures, tables and references in accordance with academic standards and publication guidelines and analyze data to help entrepreneurial decisions using critical thinking skills.	U	C	Instructor-created exams / Home Assignments /Seminar Presentation
CO5	Ethically and responsibly apply numerical methods in research, aknowledging	Ap	F	Seminar Presentation /Quiz

	limitations and uncertainties.			
CO6	Identify appropriate case study designs and data collection methods for specific research questions and contexts.	R	P	Seminar Presentation/ Group Tutorial Work

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Course Outcomes (CO):

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	
	Sections from References:			
II			**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	
	Sections from References:			
III			**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	
	Sections from References:			
IV			**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	

	Sections from References:			
V	**Open Ended Module:**		**12**	
	1	Analysis of a case study	12	
	Sections from References:			

Books and References:

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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	2	2	3	-	-	-	-
CO 2	-	-	2	-	-	-	-	-	-	3	-	2
CO 3	-	2	-	3	2	3	1	2	3	-	-	-
CO 4	3	2	2	-	-	3	3	1	-	3	3	-
CO 5	2	-	2	-	-	-	1	-	-	3	-	3
CO 6	-	-	3	-	-	2	1	2	-	3	-	-

Correlation Levels:

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

Assessment Rubrics:

4. Quiz / Assignment/ Quiz/ Discussion / Seminar
5. Midterm Exam
6. Programming Assignments (20%)
7. Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	