

# **PERIYAR UNIVERSITY**

NAAC A++ Grade State University - NIRF Rank 59 – ARRIA Rank 10

## **SALEM – 636 011**



## **M.Sc., Biostatistics**

### **(SEMESTER PATTERN)**

**(Under Choice Based Credit System)**

**(For Periyar University Department)**

### **REGULATIONS AND SYLLABUS**

**(Candidates admitted from 2023 - 2024 onwards)**

**TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION  
CHENNAI – 600 005**

## **PREAMBLE**

### **PERIYAR UNIVERSITY VISION AND MISSION**

#### **Vision**

- Periyar University aims towards excellence in education, research, promoting invention, innovation and preserving cultural identity for future generation.

#### **Mission**

- Provide a vibrant learning environment, fostering innovation and creativity inspired by cutting edge research
- Aspire to be a national leader in developing educated contributors, career ready learners and global citizens
- Provide well equipped facilities for teaching, research, administration and student life
- Have well defined autonomous governance structure
- To make a significant, consistent and sustainable contribution towards social, cultural and economic life in Tamil Nadu, India.

#### **Values**

- Motivation of students to be responsible citizens making them aware of their societal role
- Inculcate scientific temper, honesty, integrity, transparency, empathy and ethical values amidst students
- Impart a desire for lifelong learning to foster patriotic sensibility, accountability and holistic well being
- Provide conducive and cosmopolitan environment for innovation and free thinking.
- Imbibe value-based education leading to inclusive growth.

#### **Goals**

- Become a global leader in teaching, research, invention and innovation
- Make significant contribution to advancement of knowledge through quality teaching and innovative research
- Produce graduates possessing creativity and reflective thoughts, strong analytical skills and a passion for learning

- Be a part in social and economic upliftment of society to infuse sense of social and national responsibility among students.

## **DEPARTMENT VISION AND MISSION**

### **Vision**

- To centre stage statistical knowledge in the curriculum in-still analytical and logical thinking among students and promote statistical thought as an important area of human thought.

### **Mission**

- To encourage students to conduct student projects to develop their analytical and logical thinking.
- To establish industry links to develop statistical models and help the industry.
- To conduct outreach programmes for the socially marginalized students.
- The department creates an environment where the faculty and continue to grow as teachers and scholars, while providing public and professional service.

## **The Process for Defining Vision and Mission of the Department**

The following steps are followed to establish Vision and Mission for the Department of Statistics;

- Step 1 : The Vision and Mission of the Periyar University is taken as the basis.
- Step 2: The Department conducts brain-storming sessions with the faculty members on the skill-set required by the local and global employers, Industry Advances in Technology and R and D, and the draft copy of the Vision and Mission of the Department is drafted.
- Step 3: The views from Stake Holders, Industrial Experts and Board of Studies (BOS) on the draft are also collected and incorporated to revise the draft version based on their inputs.
- Step 4: The accepted views are analyzed and reviewed to check the consistency with the vision and mission of the institute.

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# M.Sc. – BIOSTATISTICS

## 1 COURSE OBJECTIVES

- The objectives of M.Sc., Biostatistics Programme are to promote the knowledge in statistical theory, methodology and epidemiology. The Programme provides training in statistical theory, methodology, computer systems, data management and epidemiology. This Programme includes a practicum, involving collaboration between health science professionals and students.
- Demonstrate the ability to use Statistics skills for formulating and tackling real world problems.
- Recognize the importance of statistical modelling and computing in the field of Biostatistics.
- Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations with the medical data set.
- Develop Problem-solving skills that are required to solve different types of Statistics related problems with well-defined solutions. Investigative skills, including skills of independent thinking of Statistics-related issues and problems
- Develop analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Statistics and ability to translate them with popular language when needed; develop ICT skills.
- To transform graduates with sufficient strength in statistics so as to be employed in the industry, Research and development and academic sides. The course is designed to impact professional knowledge and practical skills to the students.

## 2 CONDITIONS FOR ADMISSION

- Candidates who have passed Bachelor's degree and has studied at least 3 courses each of one-year duration or 6 courses each of one semester duration in Statistics under 10+2+3 scheme of examination with the minimum 50% marks in aggregate or equivalent CGPA from a recognized Institute/ University are eligible.
- Candidates who have passed Bachelor's degree in Mathematics with at least one paper in Statistics under 10+2+3 scheme of examination with the minimum 50% marks in aggregate or equivalent CGPA from a recognized Institute/ University are eligible.

## 3 DURATION OF THE COURSE

- It consists of two academic years divided into four semesters. Each semester consists of 90 working days.

## 4 SCHEME OF EXAMINATIONS

- As per the CBCS pattern with SE (Secured External Examinations score) and IA (Internal Assessment score)

## 5 CAREER PROSPECTS

Statistician jobs can be found in government and semi-government institutes in the public and private sectors and in factories. Statistics jobs can include teaching in research institutions and establishments dedicated to higher education. Statistics career has excellent potential. Some of the job options are mentioned below:

### 5.1 Government Sector

Central Government Jobs	State Government Jobs
Indian Statistical Service (ISS)	Assistant Statistical Invigilator
Senior Scientist, (CSRT)	Statistical Inspector
Scientist, (Indian Council of Medical Research)	Assistant Director (Eco. and Stat. Dept.)
Statistical Invigilator	Director/ Joint Director
Research Officer	Block Health Statistician
NSSO	Research and Scientific Officer
CSO	College/ University Professor

### 5.2 Private Sectors

Statistician, Data Analyst, Data Scientist, Risk Analyst, Biostatistician, Research Analyst, Scientist, etc.

### 5.3 Future Scope

After pursuing a Master of Biostatistics, candidates can go for further education in Ph.D. Statistics.

## 6 CURRICULUM DESIGN

Semester –I	Cred it	Hrs	Semester- II	Cred it	Hrs	Semester -III	Cred it	Hrs	Semester –IV	Cred it	Hrs
1.1. Core-I	4	5	2.1. Core IV	4	5	3.1. Core-VII	4	5	4.1. Core-XI	4	5
1.2. Core-II	4	5	2.2. Core-V	4	5	3.2 Core-VIII	4	5	4.2 Core-XII	4	5
1.3. Core-III	4	6	2.3 Core – VI	4	5	3.3 Core – IX	4	4	4.3. Statistics Practical – IV	2	4
1.4 Discipline Centric Elective - I	3	5	2.4 Discipline Centric Elective – III	3	4	3.4. Core-X	4	4	4.4. Project with viva voce	7	12

1.5 Generic Elective- II	3	5	2.5 Generic Elective - IV	3	3	3.5 Discipline Centric Elective - V	3	4	4.5. Elective - VI (Industry / Entrepren eurship) 20% Theory 80% Practical	2	4
1.6. Statistics Practical – I	2	4	2.6. Statistics Practical – II	2	4	3.6. Statistics Practical – III	2	4	4.6. Extension Activity	1	-
-	-	-	2.7. NME I (MOOC/S WAYAM)	2	2	3.7. NME II	4	4	-	-	-
-	-	-	2.8. Fundament al of Human Rights	2	2	3.8. Internship / Industrial Activity	2	-	-	-	-
	<b>20</b>	<b>30</b>		<b>24</b>	<b>30</b>		<b>27</b>	<b>30</b>		<b>20</b>	<b>30</b>
<b>Total Credit Points -91</b>											

## 7 COURSE STRUCTURE

Se me ster	Sl. No.	Course Code	Title of the Course	Cr ed it	Contact Hrs per Week	Int. Ma rks	Ext. Mar ks	Tot. Mark s
<b>I</b>	1	23UPBST2C01	CC1 – Probability and Distribution Theory	4	5	25	75	100
	2	23UPBST2C02	CC2 - Sampling Methods	4	5	25	75	100
	3	23UPBST2C03	CC3 – Introduction to Biostatistics	4	6	25	75	100
	4	23UPBST2E01/ 23UPBST2E02	<b>Elective I (Generic / Discipline Specific) (One from Group A)</b> Basic Epidemiology / Statistical Genetics	3	5	25	75	100
	5	23UPBST2E03/ 23UPBST2E04	<b>Elective II (Generic / Discipline Specific) (One from Group B)</b> Official Statistics / Population Studies	3	5	25	75	100
	6	23UPBST2L01	Statistics Practical – I	2	4	40	60	100



				<b>20</b>	<b>30</b>			<b>600</b>
<b>II</b>	7	23UPBST2C04	CC4 – Estimation Theory	4	5	25	75	100
	8	23UPBST2C05	CC5 – Clinical Trials	4	5	25	75	100
	9	23UPBST2C06	CC6 – Survival Analysis	4	5	25	75	100
	10	23UPBST2E05/ 23UPBST2E06	<b>Elective III (Generic / Discipline Specific) (One from Group C)</b> Time Series Analysis / Machine Learning Techniques	3	4	25	75	100
	11	23UPBST2E07/ 23UPBST2E08	<b>Elective-IV (Computer / IT related) (One from Group D)</b> Stochastic Processes / Statistical Computation using Python	3	3	25	75	100
	12	23UPBST2L02	Statistics Practical – II	2	4	40	60	100
	13	23UPBST2N01	Non-Major Elective 1 (MOOC/SWAYAM)	2	2	25	75	100
	14	23UPPGC1H01	Fundamentals of Human Rights	2	2	25	75	100
			<b>24</b>	<b>30</b>			<b>800</b>	
<b>III</b>	15	23UPBST2C07	CC7 – Categorical Data Analysis	4	5	25	75	100
	16	23UPBST2C08	CC8 –Testing of Statistical hypothesis	4	5	25	75	100
	17	23UPBST2C09	CC9 –Multivariate Analysis	4	4	25	75	100
	18	23UPBST2C10	CC10- Applied Regression analysis	4	4	25	75	100
	19	23UPBST2E09/ 23UPBST2E10	<b>Elective V (Generic / Discipline Specific) (One from Group E)</b> Research Methodology in Statistics / Statistical Quality Control	3	4	25	75	100
	20	23UPBST2L03	Statistics Practical – III	2	4	40	60	100
	21	23UPBST2N02 23UPBST2N03 23UPBST2N04 23UPBST2N05	Non-Major Elective 2	4	4	25	75	100
	22	23UPBST2I01	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	2	-	-	100	100
				<b>27</b>	<b>30</b>			<b>800</b>
		23	23UPBST2C11	CC11 – Design of	4	5	25	75

IV			Experiments					
	24	23UPBST2C12	CC12– Longitudinal Data Analysis	4	5	25	75	100
	25	23UPBST2L04	Statistics Practical – IV	2	4	40	60	100
	26	23UPBST2P01	Project with viva voce	7	12	40	60	100
	27	23UPBST2E11/ 23UPBST2E12	<b>Elective - VI (Industry / Entrepreneurship) –</b> Statistical Analysis in JASP 20% Theory 80% Practical / Non-parametric Inference	2	4	25	75	100
	28	23UPBST2X01	Extension Activity	1	-		100	100
				<b>20</b>	<b>30</b>	-	-	<b>600</b>
			Total	<b>91</b>		-	-	<b>2800</b>
<b>VALUE ADDED COURSES</b>								
	29	23UPBST2V01	Statistical Techniques using Open-Source Software	-	-	-	100	100
	30	23UPBST2V02	Statistics for Researchers	-	-	-	100	100
	31	23UPBST2V03	Computer Oriented Statistical Methods	-	-	-	100	100

\* Practical examinations should be conducted at end of the respective semester

## 8. PROGRAMME OUTCOMES (PO) AND PROGRAMME SPECIFIC OUTCOMES (PSO)

### Programme Outcomes (Pos)

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

<b>Programme Specific Outcomes (PSOs)</b>	<p><b>PSO1 – Placement</b> To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.</p> <p><b>PSO 2 - Entrepreneur</b> To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.</p> <p><b>PSO3 – Research and Development</b> Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.</p> <p><b>PSO4 – Contribution to Business World</b> To produce employable, ethical and innovative professionals to sustain in the dynamic business world.</p> <p><b>PSO 5 – Contribution to the Society</b> To contribute to the development of the society by collaborating with stakeholders for mutual benefit.</p>
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**Cognitive Domain:** (Lower levels: K1: Remembering; K2: Understanding; K3: Applying; Higher levels: K4: Analysing ; K5: Evaluating; K6: Creating)

## 9 CREDIT DISTRIBUTION FOR M.SC. BIostatISTICS

### First Year: Semester - I

Part	Courses	Credit	Hours per Week(L/T/P)
Part A	3 Core Courses (CC1, CC2, CC3)	12	16
	2 Elective Course (Generic / Discipline Specific) ED1, ED2	06	10
Part B	Skill Enhancement Course -SEC – Statistics Practical – I	02	04
		<b>20</b>	<b>30</b>

### Semester-II

Part	Courses	Credit	Hours per Week(L/T/P)
Part A	3 Core Courses (CC4, CC5, CC6)	12	15
	2 Elective Course (Generic / Discipline Specific) ED3, ED4	06	07
Part B	Skill Enhancement Course -SEC - Statistics Practical – II	02	04
Part C	Non-Major Elective 01	02	02
	Fundamental Rights	02	02
		<b>24</b>	<b>30</b>

### Second Year: Semester-III

Part	Courses	Credit	Hours per Week(L/T/P)
Part A	3 Core Courses (CC7, CC8, CC9, CC10)	16	18
	1 Elective Course ED5	03	04
Part B	Skill Enhancement Course -SEC - Statistics Practical – III	02	04
Part C	Non-Major Elective 2	04	04
Part D	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	02	-
		<b>27</b>	<b>30</b>

### Semester-IV

Part	Courses	Credit	Hours per Week(L/T/P)
Part A	2 Core Courses (CC11, CC12)	08	10
	Elective Course - 1 (ED6)	02	04
Part B	Skill Enhancement Course – SEC- Statistics Practical – IV	02	04

	Project with Viva voce (CP)	07	12
Part C	Extension Activity (Can be carried out from Sem II to Sem IV)	01	-
		<b>20</b>	<b>30</b>

### Component wise Credit Distribution

Credits	Sem I	Sem II	Sem III	Sem IV	Total
<b>Part A</b> (CC, ED, CP)	18	18	19	10	<b>65</b>
<b>Part B</b>					
(i) Discipline – Centric / Generic Skill - (SEC- Practical)	2	2	2	2	<b>08</b>
(ii) Non-Major Elective	-	2	4	-	<b>06</b>
(iii) Summer Internship / Industrial Training	-	-	2	-	<b>2</b>
(v) Project with viva voce	-	-	-	7	<b>7</b>
<b>Part C</b> Extension Activity	-	-	-	1	<b>1</b>
Fundamental of Human Rights	-	2			<b>2</b>
<b>Total</b>	<b>20</b>	<b>24</b>	<b>27</b>	<b>20</b>	<b>91</b>

**Part A component and Part B (i) will be taken into account for CGPA calculation for the postgraduate programme and the other components Part B (ii) and Part C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree.**

### M.Sc. Biostatistics

	First Year: Semester-I	Credit	Hours per week(L/T/P)
Part A	CC1 Probability and Distribution Theory	04	05(4L + 1T )
	CC2 Sampling Methods	04	05(4L + 1T )
	CC3 Introduction to Bio-Statistics	04	06(4L + 2T)
	Elective I(Generic / Discipline Specific)(One from Group A)	03	05(3L + 2T )
	Elective II(Generic / Discipline Specific)(One from Group B)	03	05 (3L + 2T )
Part B	Skill Enhancement Course -SEC - Statistics Practical-I	02	04 P
	<b>Total</b>	<b>20</b>	<b>30</b>

	<b>First Year: Semester-II</b>	<b>Credit</b>	<b>Hours per week(L/T/P)</b>
Part A	CC4 Estimation Theory	4	5 (4L + 1T)
	CC5 Clinical Trials	4	5 (4L + 1T)
	CC6 Applied Regression Analysis	4	5 (4L+ 1T)
	Elective III (Generic / Discipline Specific) (One from Group C)	3	4 (3L+1T)
	Elective-IV (Computer / IT related) (One from Group D)	3	3 (2L+1T)
Part B	Skill Enhancement Course -SEC 2, - Statistics Practical – II	2	4 P
Part C	Non major Elective - I	2	2
	Fundamentals of Human Rights	2	2
	<b>Total</b>	<b>24</b>	<b>30</b>
	<b>Second Year: Semester-III</b>	<b>Credit</b>	<b>Hours per week(L/T/P)</b>
Part A	CC7 Categorical Data Analysis	4	5(4L+1T)
	CC8 Testing of hypothesis	4	5 (4L+1T)
	CC9 Multivariate Analysis	4	4(3L+1T)
	CC10 Survival analysis	4	4 (3L+1T)
	Elective V (Generic / Discipline Specific) (One from Group E)	3	4 (3L + 1T)
Part B	Skill Enhancement Course -SEC 3 – Statistics Practical – III	2	4
	Non-Major Elective - II	4	4
Part C	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	2	-
	<b>Total</b>	<b>27</b>	<b>30</b>
	<b>Second Year: Semester-IV</b>	<b>Credit</b>	<b>Hours per week(L/T/P)</b>
Part A	CC11– Design of Experiments	4	5 (4L+1T)
	CC12 - Stochastic Process	4	5 (4L+1T)
	Elective VI (Generic / Discipline Specific) (One from Group F)	2	4 (3L + 1T)
Part B	Discipline – Centric / Generic Skill - (SEC- Practical) SEC 4- Statistics Practical – IV	2	4 P

	(v) Project with viva voce	7	12 P
Part C	Extension Activity	1	-
	<b>Total</b>	<b>20</b>	<b>30</b>
	<b>Over All Total Credits</b>	<b>91</b>	

### Consolidated Table for Credits Distribution

	Category of Courses	Credits for each Course	Number of Courses	Total Credits	Total Credits for the Programme
PART A	Core + Elective + Project with viva voce	<b>48+</b> <b>17+</b> <b>7</b>	<b>12 +</b> <b>6 +</b> <b>1</b>	<b>72</b>	<b>80 (CGPA)</b>
PART B	Skill Enhancement Courses (Practical)	<b>8</b>	<b>4</b>	<b>8</b>	
PART C	(NMEI and NMEII)	<b>(2+4)</b>	<b>(1+1)</b>	<b>10</b>	<b>11 (Non CGPA)</b>
(i)	Fundamentals of Human Rights	<b>2</b>	<b>1</b>		
(ii)	Summer Internship	<b>2</b>	<b>1</b>		
(iii)	Extension Activity	<b>1</b>	<b>1</b>	<b>1</b>	
(iv)					
	<b>Total Credits</b>			<b>91</b>	

### Marks and Grades

The following table gives the marks, grade points, letter grades and classification to indicate the performance of the candidate.

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0-4.9	U	Re-appear
<b>ABSENT</b>	<b>0.0</b>	<b>AAA</b>	<b>ABSENT</b>

C<sub>i</sub> = Credits earned for course *i* in any semester.

$G_i$  = Grade point obtained for course  $i$  in any semester

$n$  = Refers to the semester in which such courses were credited.

**a. Semester:**

**GRADE POINT AVERAGE (GPA)**

$$\text{GPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the courses}}{\text{Sum of the credits of the courses in a semester}}$$

GPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5 - 10.0	O+	First class with Exemplary*
9 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

**b. The Entire Programme:**

**CUMULATIVE GRADE POINT AVERAGE (CGPA)**

$$\text{CGPA} = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5 - 10.0	O+	First class with Exemplary*
9 and above but below 9.5	O	



8.5 and above but below 9.0	D++	First class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	<i>U</i>	Re-appear

\* The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme (Core, Elective, Non-major Electives and Extra-Disciplinary courses alone) are eligible

### CORE COURSES (CC)

S. No.	Course No.	Title of the Course
1	I	Probability and Distribution Theory
2	II	Sampling Methods
3	III	Introduction to Bio-Statistics
4	IV	Estimation Theory
5	V	Clinical Trials
6	VI	Survival analysis
7	VII	Categorical Data Analysis
8	VIII	Testing of Statistical Hypothesis
9	IX	Multivariate Analysis
10	X	Applied Regression Analysis
11	XI	Design of Experiments
12	XII	Longitudinal Data Analysis

### Elective Courses - ED

Group	No.	Title of the Course	
A	I	1	Basic Epidemiology (Generic Specific)
	II	2	Statistical Genetics (Discipline Specific)
B	III	1	Official Statistics (Discipline Specific)
	IV	2	Population Studies (Generic Specific)
C	V	1	Time Series Analysis (Discipline Specific)
	VI	2	Machine Learning Techniques (Generic Specific)
D	VII	1	Stochastic Processes (Computer/IT related)
	VIII	2	Statistical Computation using Python (Computer/IT related)
E	IX	1	Research Methodology in Statistics (Discipline Specific)
	X	2	Statistical Quality Control (Generic Specific)

F	XI	1	Statistical Analysis in JASP (Industry)
	XII	2	Non-Parametric Inference (Entrepreneurship)

Semester I : Elective I to be chosen from Group A and Elective II to be chosen from Group B

Semester II : Elective III to be chosen from Group C and Elective IV to be chosen from Group D

Semester III : Elective V to be chosen from Group E.

Semester IV : Elective VI to be chosen from Group F.

### Skill Enhancement Courses SEC:

#### Group G (Skill Enhancement Courses)

S. No.	Course No.	Title of the Course
1	I	Statistics Practical – I
2	II	Statistics Practical – II
3	III	Statistics Practical – III
4	IV	Statistics Practical –IV

### Non-Major Elective Courses for other Departments (not for Statistics students) EDC

Students from other Departments may also choose any one of the following as Extra Disciplinary Course.

Semester	S. No.	Title of the Course
II	<b>Non- Major Elective – I</b>	
	MOOC/ SWAYAM Courses (23UPBST2N01)	
	<b>Non- Major Elective – II</b>	
III	1	Basic Statistical Methods (23UPBST2N02)
	2	Statistics for Behavioural Sciences (23UPBST2N03)
	3	Probability and Statistics for Scientists (23UPBST2N04)
	4	Statistical Data Analysis Using R (23UPBST2N05)

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For  
Theory  
papers:  
100  
marks

Internal 25 marks and External 75 marks

For Practical papers: 100 marks

Internal 40 marks and External 60 marks

### Internal Assessment

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

**Practical Courses:** For Practical oriented courses, there shall be two tests in Theory part and two tests in Laboratory part. Choose one best from Theory part and other best from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 40 marks. The duration of each test shall be one / one and a half hour.

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examinations.

### Question Paper Pattern

**Marks for Internal:** (Max.Marks:25)

<b>Internal marks distribution:</b>			
	Cycle test and model Exam	:	15 marks
	Assignment	:	05 marks
	Seminar	:	05 marks
	<b>Total</b>	:	<b>25 marks</b>

**Marks for External:** (Max.Marks:75)

<p><b>Intended Learning Skills</b></p> <p>Memory Recall / Example/ Counter Example / Knowledge about the Concepts/ Understanding</p>	<p><b>Maximum 75 Marks</b> <b>Passing Minimum: 50%</b> <b>Duration: Three Hours</b></p>
	<p><b>Part –A (10 x 2 = 20 Marks)</b> Answer <b>ALL</b> questions <b>Each Question carries 2 Mark</b></p>
	<p>Two questions from each UNIT <b>Question 1 to Question 10</b></p>
	<p><b>Part – B (5 x 5 = 25 Marks)</b> Answer <b>ALL</b> questions (internal choice) Each questions carries 5 Marks</p>
<p>Descriptions/ Application(problems)</p>	<p>Two question from each UNIT Either - or Type Both parts of each question from the same UNIT</p>
	<p><b>Question 11(a) or 11(b)</b> <b>To</b></p>
	<p><b>Question 15(a) or 15 (b)</b></p>

	<b>Part-C (3x 10 = 30 Marks)</b> Answer <b>ANY THREE</b> questions Each question carries 10 Marks
Analysis /Synthesis / Evaluation	One question from each UNIT
	<b>Question 16 To Question 20</b>

### Practical papers

<b>TIME:3 Hours, Maximum Marks: 100 marks (40(IA) + 60(SE))</b>			
<b>Internal marks distribution:</b>			
	Model Exam	:	20 marks
	Record work	:	10 marks
	Attendance	:	10 marks
	<b>Total</b>	:	<b>40 marks</b>

### Question pattern for Practical

Three questions are to be set with internal choice. All question carries equal marks.

<b>Time: 3hrs</b>		<b>Maximum marks: 60</b>	
<b>Part – A (3 x 20 = 60)</b> Answer <b>ANY THREE</b> questions (Internal choice)			
<b>External marks distribution:</b>			
	Write and Type the Programme (3 X 15)	:	45 marks
	Run the Programme (3 X 3)	:	09 marks
	Correct output (3 X 2)	:	06 marks
	<b>Total</b>	:	<b>60 marks</b>

**Project work:** (Maximum marks): IA: 40 marks and SE: 60 marks

Each question should carry the course outcome and cognitive level

**11 SYLLABUS**  
**11.1 SYLLABUS FOR CORE COURSES**

**11.1.1 Probability and Distribution Theory**

<b>Paper Number</b>		<b>I</b>					
<b>Category</b>	<b>CC</b>	<b>Year</b>	I	<b>Credits</b>	4	<b>Course Code</b>	23UPBST2C01
		<b>Semester</b>	I				
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	<b>Total</b>
		4		1		-	5
<b>Pre-requisite</b>		Undergraduate level Distribution Theory.					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>To provide theoretical knowledge on the concept of functions of random variables and its usage.</li> <li>To educate the knowledge on the both discrete and continuous distributions.</li> <li>To acquire the knowledge on deriving its characteristics of distributions.</li> </ol>					
<b>Course Outline</b>		<b>UNIT I: Probability Distribution</b> Introduction - counting – sample spaces and events, axioms of probability – Random variables, distribution function - properties, quartiles, mean variance – Conditional Probability, Bayes theorem, base rate fallacy – Joint distribution, covariance, correlation, independence – Central limit theorem					
		<b>UNIT II: Discrete &amp; Continuous Distribution</b> Uniform, Binominal, Poisson, Geometric, negative Binominal, Hypergeometric, Power series. Continuous distribution: Uniform, Normal, Exponential, Gamma, Chi-square, t, F, Lognormal, Weibull, Cauchy, Bets, Inverse Gaussian characterization of distribution: Geometric, normal and exponential.					
		<b>UNIT III:</b> Brief review of distribution theory, functions of random variables and their distributions using Jacobian of transformation, Laplace and Cauchy distribution, lognormal distribution, gamma, logarithmic series.					
		<b>UNIT IV:</b> Bivariate Normal Distribution – Compound and truncated distributions of Binomial, Poisson and Normal distributions.					
		<b>UNIT V:</b> Sampling distributions, non-central chi-square distribution, t and F distributions and their properties, distributions of quadratic forms under normality and related distribution theory – Cochran’s and James theory.					
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)				Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)			
<b>Skills acquired from this course</b>		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					
<b>Recommended Text Books</b>		<ol style="list-style-type: none"> <li>Gibbons (1971): Non-parametric inference, Tata McGraw Hill.</li> <li>Rohatgi, V.K. and Md. Whsanes Saleh, A.K.(2002): An introduction to probability &amp; Statistics, John Wiley and Sons.</li> <li>Parathasathy, K.R.(1977), introduction to probability and Measure, Thomson wadsworth.</li> </ol>					
<b>Reference Books</b>		<ol style="list-style-type: none"> <li>Rao, C.R. (1973): Linear statistical inference and its applications, 2ed, Wiley Eastern.</li> <li>Mood, A.M. &amp; Graybill, F.A. and Boes, D.C. : Introduction to</li> </ol>					

	<p>the theory of statistics, McGraw Hill. Johnson,S. &amp; Kotz,(1972): Distributions in Statistics, Vol. I, II &amp; III, Houghton &amp; Mifflin.</p> <p>3. Dudewicz, E.J., Mishra, S.N.(1988) : Modern mathematical statistics, John Wiley. Searle, S.R.(1971) : Linear models, John Wiley.</p> <p>4. Primal Mukopadhyay (2006) Mathematical Statistics, 3<sup>rd</sup> edition, New Central Book Agency</p>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able

1. To understand the knowledge on importance of the probability and its role.
2. To interpret the properties of some discrete and continuous distributions.
3. To analyse the functions of random variables in various distributions.
4. To interpret the bivariate distributions for discrete and continuous distributions
5. To comprehend the data based on sampling distributions.

### CO-PO Mapping (Course Articulation Matrix)

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

**S-Strong, M-Medium, W-Weak**

### Level of Correlation between PSO's and CO's

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

### 11.1.2 Sampling Methods

<b>Title of the Course</b>		<b>Sampling Methods</b>					
<b>Paper Number</b>		<b>II</b>					
<b>Category</b>	<b>CC</b>	<b>Year</b>	I	<b>Credits</b>	4	<b>Course Code</b>	23UPBST2C02
		<b>Semester</b>	I				
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		4	1	-	5		
<b>Pre-requisite</b>		Undergraduate Statistical Inference					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. To cover sampling design and analysis methods</li> <li>2. To explain and compare various sampling procedures.</li> <li>3. To understand the concepts of bias and sampling variability and strategies for reducing the bias and sampling variability.</li> </ol>					
<b>Course Outline</b>		<b>UNIT I:</b> Preliminaries – Simple Random Sampling – Estimates of population total, mean and variance – limitations of sampling- Probability Proportional to Size (PPS).					
		<b>UNIT II:</b> Midzuno sampling method - PPSWR and PPSWOR sampling methods – Ordered and Unordered estimators.					
		<b>UNIT III:</b> Stratified Sampling – Allocation Problems – Systematic Sampling Methods – Balanced, Modified and Centered systematic sampling methods – Yates corrected estimator.					
		<b>UNIT IV:</b> Ratio Estimation – Unbiased Ratio Type estimators – Regression Estimation - Double Sampling for Ratio and Regression Estimation					
		<b>UNIT V:</b> Multistage Sampling - Randomized Response Methods – Call Back Techniques					
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)			<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government.</p> <p>(To be discussed during the Tutorial hour)</p>				
<b>Skills acquired from this course</b>		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					
<b>Recommended Text Books</b>		<ol style="list-style-type: none"> <li>1. S.Sampath (2005): Sampling Theory and Methods, Narosha Publishing House.</li> <li>2. W.G. Cochran (1965): Sampling Techniques, Wiley and Sons</li> <li>3. Desraj (1976): Sampling Theory, McGraw Hill, New York.</li> </ol>					



<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. M.N.Murthy(1967) : Sampling Theory and Methods: Statistical Publishing Society, Calcutta Parimal Mukhopadhyay (2005) : Theory and Methods of Survey Sampling , Prentice Hall of India</li> <li>2. P.V.Sukhatme, B.V.Sukhatme, S.Sukhatme and C.Asok (1984) L Theory of Same Surveys with Applications, IASRI, New Delhi</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

#### CO-PO Mapping (Course Articulation Matrix)

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

**S-Strong, M-Medium, W-Weak**

#### Level of Correlation between PSO's and CO's

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

### 11.1.3 Introduction to Biostatistics

<b>Title of the Course</b>		<b>Introduction to Biostatistics</b>					
<b>Paper Number</b>		<b>III</b>					
<b>Category</b>	<b>CC</b>	<b>Year</b>	I	<b>Credits</b>	4	<b>Course Code</b>	23UPBST2C03
		<b>Semester</b>	I				
<b>Instructional Hours Per week</b>		<b>Lecture</b>	<b>Tutorial</b>		<b>Lab Practice</b>		<b>Total</b>
		4	1		--		5
<b>Pre-requisite</b>		Undergraduate level Biostatistics					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. Understand and apply statistical methods for the design of biomedical research and analysis of biomedical research data.</li> <li>2. Understand and use mathematical and statistical theory underlying the application of bio statistical methods.</li> <li>3. Learn to participate in a research team setting in study design, data coordination and management, and statistical analysis and reporting of study results.</li> <li>4. Participate in a research team in the development and evaluation of new and existing statistical methodology.</li> <li>5. Demonstrate the fundamental knowledge of clinical trial processing.</li> </ol>					
<b>Course Outline</b>		<p><b>UNIT I:</b> Introduction Definition/Phases of Clinical Trials; Study Design: Cohort, case-control and observational studies; Terminology of prospective, retrospective; treatment allocation, randomization and stratification, quality control, biases, sample size requirements, patient consent.</p> <p><b>UNIT II:</b> Processing and presentation of data - Classification of data - tabulation of data - Formation of frequency tables - Diagrammatic presentation of statistical data - bar diagrams - pie diagrams and pictograms - simple problems – Graphical presentation of statistical data - Histogram, frequency curves and Ogive curve- simple problems.</p> <p><b>UNIT III:</b> Measures of central tendency - mean, median, mode - simple problems - measures of dispersion - range, mean deviation, quartile deviation and standard deviation - relative measures of dispersion - simple problems.</p> <p><b>UNIT IV:</b> Concept of Skewness and Kurtosis - Karl Pearson's and Bowley's coefficients of Skewness- moments- coefficients of Skewness and Kurtosis - simple problems.</p> <p><b>UNIT V:</b> Correlation: Scatter diagram - simple correlation, Rank correlation. Regression - simple regression lines (without proof) – Tetro choric correlation, Phi coefficient and Kendall's co-efficient - simple problems.</p>					

Extended Professional Component (is a part of internal component only, not to be included in the External Examination Question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC-CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this Course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text</b>	<ol style="list-style-type: none"> <li>1. Sokal, P.R. and Rohlf, F.J. (1969). Bio Statistics. W.H. Freeman and Co., San Francisco</li> <li>2. Goon, A. M., Gupta, M. K., and Dasgupta, B. (2008). Fundamental of Statistics, Volume-I, World Press Ltd, Calcutta.</li> <li>3. Gupta, S. C., and Kapoor, V. K. (2000). Fundamentals of Mathematical Statistics, Tenth Edition</li> <li>4. Rao, C.R. &amp; Bhimasankaran, P.(1992) : Linear algebra, Tata McGraw Hill Pub.Co. Ltd.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Gupta S.C. and Kapoor V.K.: Fundamentals of Mathematical Statistics. Sultan Chand &amp; Sons Publications, New Delhi.</li> <li>2. Kapoor J.N and Saxana H.C : Mathematical Statistics, Sultan Chand &amp; Sons Publications, New Delhi</li> <li>3. Kulkarni M.B., Gore A.P. and Ghatp and S.B.: Statistical Tests, Satyajeet Prakashan, Pune.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, tutorials on MOOC/SWAYAM courses on the subject

#### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To apply basics level of clinical data processing.
2. To draw output on data presentation.
3. To use practical applications of measuring central tendency and dispersion concept.
4. To analyze data and find the nature of distribution using skewness and kurtosis.
5. To calculate and analyze the relationship between variables.

#### CO-PO Mapping (Course Articulation Matrix)

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

CO3	S	S	M	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S  
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Stro

ng, M-Medium, W-Weak

#### Level of Correlation between PSO's and CO's

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

#### 11.1.4 Estimation Theory

Title of the Course		Estimation Theory					
Paper Number		IV					
Category	CC	Year	I	Credits	4	Course Code	23UPBST2C04
		Semester	II				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	1	-	5		
Pre-requisite		Undergraduate level Probability Theory.					
Objectives of the Course		<ol style="list-style-type: none"> <li>To make the students to understand the basic concepts of the statistical estimation theory.</li> <li>To study the properties of ideal estimators like unbiasedness, consistency, sufficiency, completeness.</li> <li>To educate various estimation methods like method of moments, method of maximum likelihood, interval estimate, and Bayes estimate.</li> </ol>					
Course Outline		<p><b>UNIT I:</b> Sufficient statistics, Neyman, Fisher Factorisation theorem, the existence and construction of minimal sufficient statistics, Minimal sufficient statistics and exponential family, sufficiency and completeness, sufficiency and invariance.</p> <p><b>UNIT II:</b> Unbiased estimation: Minimum variance unbiased estimation, locally minimum variance unbiased estimators, Rao Blackwell – theorem. Completeness- Lehmann Scheffe theorems, Necessary and sufficient condition for unbiased estimators.</p> <p><b>UNIT III:</b> Cramer- Rao lower bound, Bhattacharya system of lower bounds in the 1-parameter regular case. Chapman -Robbins inequality.</p>					

	<p><b>UNIT IV:</b> Maximum likelihood estimation, computational routines, strong consistency of maximum likelihood estimators, Asymptotic Efficiency of maximum likelihood estimators, Best Asymptotically Normal estimators, Method of moments.</p> <p><b>UNIT V:</b> Bayes' and minimax estimation: The structure of Bayes' rules, Bayes' estimators for quadratic and convex loss functions, minimax estimation, interval estimation.</p>
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	1. V.K.Rohatgi et al(2002) : An introduction to probability and statistics, John Wiley. Lehmann, E.L. (1983): Theory of point estimation, John Wiley. 2. M. Rajagopalan and P. Dhanavanthan (2012): Statistical Inference, PHI Learning Pvt Ltd, New Delhi.
<b>Reference Books</b>	1. Zacks, S. (1971): The theory of statistical inference, John Wiley. 2. Rao, C.R. (1973): Linear statistical inference and its applications, Wiley Eastern, 2 <sup>nd</sup> ed. 3. Ferguson, T.S. (1967): Mathematical statistics, A decision theoretic approach, Academic press, New York and London. 4. Lindley, D.V. (1965): Introduction to probability and statistics, Part 2, Inference, Cambridge University Press.
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To understand the consistency, sufficiency and unbiasedness.
2. To understand the concepts and derive the uniformly minimum variance unbiased estimators.
3. To derive the inequality including CR inequality, KCR inequality and Bhattacharyainequality.
4. To estimate the parameter using method of moments, method of MLE, Interval estimation and shortest with confidence intervals.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

#### Level of Correlation between PSO's and CO's

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

#### 11.1.5 Clinical Trials

Title of the Course		Clinical Trials					
Paper Number		V					
Category	CC	Year	I	Credits	4	Course Code	23UPBST2C05
		Semester	I				
Instructional Hours per week	Lecture	Tutorial		Lab Practice		Total	
	4	1		-		5	
Pre-requisite		Undergraduate Level Statistical Models.					
Objectives of the Course		<ol style="list-style-type: none"> <li>1. The course stresses on the concepts of statistical design and analysis in biomedical research, with special emphasis on clinical trials.</li> <li>2. To learn and develop scientific view to study the statistical challenges of clinical comparison of two or more treatment.</li> </ol>					
		<b>UNIT 1:</b> Introduction to clinical trials: need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multicenter trials. Data management: data definitions, case report forms, database design, data collection systems for good clinical practice. Bioavailability, pharmacokinetics and pharmacodynamics, two-compartment model.					

<b>Course Outline</b>	<b>UNIT II:</b> Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, objectives and endpoints of clinical trials, design of Phase I trials, design of single stage and multi-stage Phase II trials.
	<b>UNIT III:</b> Design and monitoring of Phase III trials with sequential stopping, design of bio-equivalence trials. Inference for 2x2 crossover design: Classical methods of interval hypothesis testing for bioequivalence, Bayesian methods, nonparametric methods.
	<b>UNIT IV:</b> Power and sample size determination, multiplicative (or log-transformed) model, ML method of estimation, assessment of inter and intra subject variabilities, detection of outlying subjects. Optimal crossover designs: Balaams design, Two-sequence dual design. Optimal four period designs. Assessment of bioequivalence for more than two drugs, Williams design.
	<b>UNIT V:</b> Designs based on clinical endpoints: Weighted least squares method, log-linear models, generalized estimating equations. Drug interaction study, dose proportionality study, steady state analysis. Interim analysis and group sequential tests, alpha spending functions. Analysis of categorical data.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Agresti, Alan. (1996) An Introduction to Categorical Data Analysis, Wiley, New York.</li> <li>2. Marubeni .E. and Valsecchi M. G. (1994). Analyzing Survival Data from Clinical Trials and Observational Studies, Wiley.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Chow S.C. and Liu J.P.(2009). Design and Analysis of Bioavailability and bioequivalence. 3rd Edn. CRC Press.</li> <li>2. Chow S.C. and Liu J.P. (2004). Design and Analysis of Clinical Trials. 2nd Edn Marcel Dekkar.</li> <li>3. Fleiss J. L.(1989). The Design and Analysis of Clinical Experiments. Wiley.</li> <li>4. Friedman L. M. Furburg C. Demets D. L.(1998). Fundamentals of Clinical Trials, Springer.</li> <li>5. Jennison .C. and Turnbull B. W. (1999). Group Sequential Methods with Applications to Clinical Trails, CRC Press.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Students can understand the key statistical components involved in the planning and conduct of clinical trials.
2. Awareness of different populations for analysis and understand which is appropriate to address specific research
3. Students will be familiar with the use of the cross-over design.

#### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

#### Level of Correlation between PSO's and CO's

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

#### 11.1.6 Survival Analysis

Title of the Course		Survival Analysis					
Paper Number		VI					
Category	CC	Year	I	Credits	4	Course Code	23UPBST2C06
		Semester	II				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	1	-	5		
Pre-requisite		Basic knowledge in linear models and their properties					
Objectives of the Course		The main objectives of this course are to: <ol style="list-style-type: none"> <li>1. To learn the analysis of survival data.</li> <li>2. To distinguish censored and uncensored data.</li> <li>3. To visualize and communicate time-to event data, to fit and interpret failure time model.</li> </ol>					



<b>Course Outline</b>	<b>UNIT I:</b> Concepts of time, Order and random Censoring, likelihood in these cases. Life distributions- Exponential, Gamma, Weibull, Lognormal, Pareto, Linear Failure rate. Parametric inference (Point estimation, scores, MLE)
	<b>UNIT II:</b> Life tables, failure rate, mean residual life and their elementary properties. Concept of Ageing, Types of Ageing classes and their properties and relationship between them, Bathtub Failure rate, Concept of Inverse Hazard rate.
	<b>UNIT III:</b> Estimation of survival function Actuarial Estimator, Kaplan-Meier Estimator, Estimation under the assumption of IFR / DFR. Tests of exponentiality against non- parametric classes- Total time on test, Despande test.
	<b>UNIT IV:</b> Two sample problem- Gehan test, Log rank test. Mantel Haenszel test, Tarone Ware tests. Introduction to Semi- parametric regression for failure rate, Cox's proportional hazards(PH) model with one and several covariates and estimation problems in Cox's PH Model. Rank test for the regression coefficients.
	<b>UNIT V:</b> Introduction to Competing risks analysis and estimation problems in competing risk model for parametric and non- parametric semi parametric set up. Ideas of Multiple decrement life table and its applications.
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Miller, R.G. (1981): Survival analysis (John Wiley).</li> <li>2. Cox, D.R. and Oakes, D. (1984) : Analysis of Survival Data, Chapman and Hall, New York.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Elisha T Lee, John Wenyu Wang and Timothy Wenyu Patt (2003): Statistical Methods for Survival data Analysis, 3/e, Wiley Inter Science.</li> <li>2. Gross, A.J. and Clark, V.A. (1975) : Survival distribution : Reliability applications in the Biomedical Sciences, John Wiley and Sons.</li> <li>3. Elandt Johnson, R.E. Johnson N.L.: Survival Models and Data Analysis, John Wiley and sons.</li> <li>4. Kalbfleisch J.D. and Prentice R.L.(1980), The Statistical Analysis of Failure Time Data, JohnWiley.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

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

1. Understand the elements of reliability, hazard function and its applications.
2. Understand the concept of censoring, life distributions and ageing classes.
3. Estimate nonparametric survival function of the data.
4. Explain test of exponentiality against nonparametric classes, two sample problems.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

### 11.1.7 CATEGORICAL DATA ANALYSIS

Title of the Course		CATEGORICAL DATA ANALYSIS							
Paper Number		VII							
Category	CC	Year	II	Credits	4	Course Code	23UPBST2C07		
		Semester	III						
Instructional Hours per week		Lecture	4	Tutorial	1	Lab Practice	-	Total	5
		<b>Pre-requisite</b>		Fundamentals of data and data source					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. The course covers models for categorical data, two way and multi way contingency tables, homogeneity and independence</li> <li>2. Generalized linear models for categorical data, logistic regression, log linear models for categorical data and diagnostics of models.</li> <li>3. Write clear and precise proofs.</li> <li>4. Communicate effectively in both written and oral form.</li> <li>5. Demonstrate the ability to read and learn mathematics and/or statistics independently.</li> </ol>							
<b>Course Outline</b>		<p><b>UNIT I:</b> Models for Binary Response Variables, Log Linear Models, Fitting Log linear and Logic Models-Building and applying Log Linear Models, Log- Linear- Logit Models for Ordinal Variables.</p> <p><b>UNIT II:</b> Multinomial Response Models - Models for Matched Pairs-Analyzing Repeated Categorical Response Data - Asymptotic Theory for Parametric Models - Estimation Theory for Parametric Models.</p> <p><b>UNIT III:</b> Classical treatments of 2 and 3-way contingency tables- Tests for independence and homogeneity of proportions- measures of association and nonparametric methods - Generalized linear models - Logistic regression for binary - multinomial and ordinal data – Log - linear models - Modeling repeated measurements- generalized estimating equations.</p> <p><b>UNIT IV:</b> Introduction to contingency tables: 2×2 and r×c tables -Fishers exact test - Odds ratio and Logit, other measures of association - Introduction to 3 - way tables – full independence and conditional independence - collapsing and Simpsons paradox.</p> <p><b>UNIT V:</b> Polytomous logit models for ordinal and nominal response- Log-linear models (and graphical models) for multi-way tables - Causality, repeated measures, generalized least squares - mixed models, latent-class models, missing data, and algebraic statistics approach</p>							
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)			Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)						
<b>Skills acquired from this course</b>		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill							

<b>Recommended Text Books</b>	1. Agresti, Alan (1996). An Introduction to Categorical Data Analysis, Wiley.
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Bergsma, W., Croon, M.A. and Hagenars, J.A. (2009). Marginal Models: For Dependent, Clustered, and Longitudinal Categorical Data. Springer.</li> <li>2. Bishop, Y.M., Fienberg, S.E. and Holland, P.W. (1975). Discrete Multivariate Analysis: Theory and Practice, MIT Press.</li> <li>3. Edwards, D. (2000). Introduction to Graphical Modeling (Second Edition). Springer.</li> <li>4. Fienberg, S.E. (1980). The Analysis of Cross-Classified Categorical Data. MIT Press.</li> <li>5. Wasserman, L. (2004). All of Statistics: A Concise Course in Statistical Inference. Springer.</li> <li>6. Whittaker, J. (1990). Graphical Models in Applied Multivariate Statistics. Wiley.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. This course is devoted to the analysis of data in which the response variables are categorical: either qualitative or quantitative with a limited number of values. Explanatory variables can be categorical or continuous.
2. Give an account of the sampling strategies for categorical data;
3. Analyze a two-way contingency table
4. Carry out exact inference for a three-way contingency table; build and apply logit and log linear models
5. Be able to interpret the results in practical examples.

<b>Mapping with Programmes Outcomes</b>										
<b>Cos</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	S	L	L	M	M	M	S	L	M	M
<b>CO2</b>	L	M	S	L	M	S	L	L	M	L
<b>CO3</b>	S	S	S	L	L	M	M	L	L	M
<b>CO4</b>	S	M	L	M	L	S	L	L	M	M
<b>CO5</b>	M	M	L	M	S	L	M	L	S	L

**S-Strong, M-Medium, W-Weak**

### Level of Correlation between PSO's and CO's

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

### 11.1.8 Testing of Statistical Hypothesis

Title of the Course		Testing of Statistical Hypothesis					
Paper Number		VIII					
Category	CC	Year	II	Credits	4	Course Code	23UPBST2C08
		Semester	III				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	1	-	5		
Pre-requisite		Under Graduate Level Testing of Statistical Hypothesis.					
Objectives of the Course		<ol style="list-style-type: none"> <li>To get theoretical knowledge in Statistical Testing procedure.</li> <li>To provide knowledge about Most Powerful test and how to build it.</li> <li>To understand Hypothesis testing concepts.</li> <li>To develop analytical thinking in statistical testing of hypothesis.</li> </ol>					
Course Outline		<p><b>UNIT I:</b> Uniformly most powerful tests, the Neyman-Pearson fundamental Lemma, Distributions with monotone likelihood ratio Problems.</p> <p><b>UNIT II:</b> Generalization of the fundamental lemma, two sided hypotheses, testing the mean and variance of a normal distribution.</p> <p><b>UNIT III:</b> Unbiasedness for hypotheses testing, similarly and completeness, UMP unbiased tests for multi parameter exponential families, comparing two Poisson or Binomial populations, testing the parameters of a normal distribution (unbiased tests), comparing the mean and variance of two normal distributions.</p> <p><b>UNIT IV:</b> Symmetry and invariance, maximal invariance, most powerful invariant tests.</p> <p><b>UNIT V:</b> SPRT procedures, likelihood ratio tests, locally most powerful tests, the concept of confidence sets, non-parametric tests.</p>					

Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. V.K.Rohatgi et. al (2002): An introduction to probability and statistics, John Wiley.</li> <li>2. Lehmann, E.L. (2005) : Testing of statistical hypothesis, 3<sup>rd</sup> Edn., John Wiley.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Ferguson, T.S. (1967) : Mathematical statistics, A decision theoretic approach, Academic press.</li> <li>2. Rao, C.R. (1973) : Linear statistical inference and its applications, Wiley Eastern, 2nd ed.</li> <li>3. Gibbons, J.D. (1971) : Non-parametric statistical inference, McGraw Hill.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

#### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

#### CO-PO Mapping (Course Articulation Matrix)

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

**S-Strong, M-Medium, W-Weak**

#### Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	3	3	3	3	3
<b>CO2</b>	3	3	3	3	3
<b>CO3</b>	3	3	3	3	3

<b>CO4</b>	3	3	3	3	3
<b>CO5</b>	3	3	3	3	3
<b>Weightage</b>	15	15	15	15	15
<b>Weighted percentage of Course Contribution to Pos</b>	3.0	3.0	3.0	3.0	3.0

### 11.1.9 Multivariate Analysis

<b>Title of the Course</b>		<b>Multivariate Analysis</b>				
<b>Paper Number</b>		<b>IX</b>				
<b>Category</b>	<b>CC</b>	<b>Year</b>	<b>II</b>	<b>Credits</b>	4	<b>Course Code</b>
		<b>Semester</b>	<b>III</b>			
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>	
		3	1	-	4	
<b>Pre-requisite</b>		Univariate and Multivariate distribution theory, Linear Algebra				
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. To impart basic theoretical knowledge about multivariate normal distribution, its properties to deal with multi-dimension data. To Derive inference based on multi-variate statistical analysis concerning Mean vector and Covariance matrix.</li> <li>2. To provide requisite knowledge to handle multi-dimensional data with regard to dimensionality reduction using Principal Component and Factor Analysis. To imbibe skills to classify and assign a new item/object to any of the two or more populations using Discrimination and Classification.</li> <li>3. To instruct theoretical knowledge to group variables or items that belong to multi-dimensional data using Cluster algorithms</li> </ol>				
<b>Course Outline</b>		<p><b>UNIT I:</b> Multivariate Normal Distribution and Its Properties. Maximum Likelihood Estimators of Parameters, Distribution of Sample Mean Vector, Sample Dispersion Matrix.</p> <p><b>UNIT II:</b> Partial and multiple correlation coefficients- Null distribution - Application in testing. Null distribution of Hotelling's <math>T^2</math> statistics. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population.</p> <p><b>UNIT III:</b> Classification and discrimination procedures for discrimination between two multivariate normal populations – Linear Discriminant function, Mahalanobis Distance, tests associated with Discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations.</p> <p><b>UNIT IV:</b> Principal component Analysis, Canonical variables and canonical correlation, clustering- similarity measures- hierarchical algorithms- Single Linkage, Non-hierarchical Clustering.</p>				

	<b>UNIT V: Contingency Tables, Correspondence Analysis for Two Dimension Contingency Table.</b>	
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	
<b>Recommended Text Books</b>	1. Anderson, T.W. (1983): An Introduction To Multivariate Statistical Analysis. 2nd Ed. Wiley. 2. Johnson, R. & Wichern (2008): Applied Multivariate Statistical Analysis, Pearson, 6 <sup>th</sup> ed.	
<b>Reference Books</b>	1. Brain S. Everitt and Graham Dunn (2001): Applied Multivariate Data Analysis, 2nd Ed. (chap 4) 2. Neil H. Timm (2002): Applied Multivariate Analysis – Springer-Verlag 3. Dallas E. Johnson (1998): Applied Multivariate Methods For Data Analysts- Duxbury Press 4. William R Dillon and Mathew Goldstein (1984): Multivariate Analysis Methods And Applications, John Wiley	
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.	

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

### CO-PO Mapping (Course Articulation Matrix)

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



CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

#### Level of Correlation between PSO's and CO's

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

#### 11.1.10 Applied Regression Analysis

Title of the Course		Applied Regression Analysis					
Paper Number		X					
Category	CC	Year	II	Credits	4	Course Code	23UPBST2C10
		Semester	III				
Instructional Hours per week	Lecture	Tutorial		Lab Practice	Total		
	3	1		-	4		
Pre-requisite		Basic skills in correlation and regression					
Objectives of the Course		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>To develop a deeper understanding of the linear and non-linear regression model and its limitations.</li> <li>To learn how to develop regression model and apply for the specific perspective data appropriate manner.</li> </ol>					
Course Outline		<p><b>UNIT I:</b> Multiple Linear Regression. Estimation of Model parameters. Least square estimation of the regression coefficients-properties of least square estimators. Maximum likelihood Estimation-Tests for the significance of regression- test on individual regression coefficients – Confidence interval on the regression coefficients- Confidence interval estimation of mean Response-Prediction –Standard regression coefficients-UNIT normal scaling-UNIT length scaling.</p> <p><b>UNIT II:</b> Residual analysis. Definition and properties of residuals-methods of scaling Residuals-Residual plots- PRESS statistic- formal test for lack of fit. Variance -Stabilizing transformation-transformations to linearize Models-Generalized and weighted least squares. Indicator variables-concept and use.</p>					

	<b>UNIT III:</b> Model building problem-variable Selection-Stepwise regression methods. Multicollinearity - sources and effects of multicollinearity –Diagnostics and methods for detecting multicollinearity.
	<b>UNIT IV:</b> Polynomial regression. Polynomial model in one variable. Piecewise Polynomial fitting (Splines) - Non parametric regression. Kernel regression – Locally Weighted regression. Polynomial model in two or more variables. Non-linear regression-nonlinear least square-transformation to linear model-parameter estimation.
	<b>UNIT V:</b> Generalized Linear Models (GLM). Logistic Regression- Estimation of parameters in logistic regression Models-Interpretation of parameters in logistic regression models. Poisson regression-GLM-link function and linear prediction- parameter estimation in GLM.
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	1. Montgomery. D.C. Peck E.A. Vining. G.G. (2003), Introduction to Linear Regression Analysis, John Wiley & sons, Inc, New York. 2. Draper. N.R. and Smith. H. (1998) Applied regression Analysis, John Wiley.
<b>Reference Books</b>	1. Montgomery. D.C. Peck E.A. Vining. G.G. (2003) Introduction to Linear Regression Analysis, John Wiley & sons, Inc, New York. 2. Draper. N.R. and Smith. H. (1998) Applied regression Analysis, John Wiley 3. Hosmer, D.W, Lemeshow, S., and Sturdivant, R. X. (2013) Applied Logistic Regression, Third Edition, John Wiley and Sons.

### Course Learning Outcome (for Mapping with POs and PSOs)

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

1. Apply simple linear regression model to real life examples.
2. Understand multiple linear regression models with applications and concept of Multicollinearity and autocorrelation.
3. Compute multiple and partial correlation and checking residual diagnostic
4. to validate model.

5. Apply Logistic and Non-linear regression models and its implementation in real life situation.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

### 11.1.11 Design of Experiments

Title of the Course		Design of Experiments					
Paper Number		XI					
Category	CC	Year	II	Credits	4	Course Code	23UPBST2C11
		Semester	IV				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total
		4		1		-	5
Pre-requisite		Matrix algebra & Linear Models.					
Objectives of the Course		<ol style="list-style-type: none"> <li>1. To get theoretical knowledge in Statistical Design of Experiments and analysis of variance</li> <li>2. To build strong theoretical foundation in Orthogonal latin squares, Hyper Graeco Latin squares, factorial and fractional factorial experiments, PIBD, inter and intra blocks, split plot, analysis covariance, Response surface methodology.</li> <li>3. To develop analytical thinking in problem solving skills</li> </ol>					

<b>Course Outline</b>	<b>UNIT I:</b> Review of basic designs; Orthogonal latin squares, Hyper Graeco Latin squares – analysis of variance – multiple comparisons – multiple range tests - Missing plot technique.
	<b>UNIT II:</b> General factorial experiments, study of 2 and 3 factorial experiments in randomized blocks; complete and partial confounding; Fractional designs for symmetric factorials; basic idea of asymmetric factorials.
	<b>UNIT III:</b> General block design and its information matrix (C), criteria for connectedness, balanced and orthogonality; BIBD – recovery of interblock information; PBIBD(2).- Association scheme, Intrablock analysis, Lattice Design –analysis; Youden design – intrablock analysis;
	<b>UNIT IV:</b> Nested and split plot designs – Two stage nested designs, split plot designs, split plot plot designs, strip-split designs, Analysis of covariance with one, two covariates; clinical trials.
	<b>UNIT V:</b> Response surface methodology - first order and second order rotatable designs, applications.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Das, M.N. and Giri, N. (1979) : Design and analysis of experiments, Wiley Eastern.</li> <li>2. John, P.W.M. (1971) : Statistical design and analysis of experiments, Macmillan.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Montgomery, C.D. (2001) : Design and analysis of experiments, John Wiley, New York.</li> <li>2. Robert, O., Kuehl (2000) : Design of experiments. Statistical principles of research design and analysis, Duxbury.</li> <li>3. Federer, W.T.(1963) : Experimental design; Theory and application, Oxford &amp; IBH publishing Co.</li> <li>4. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook (2016), Response Surface Methodology: Process and Product Optimization Using Designed Experiments, 4th Edition.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

**CO-PO Mapping (Course Articulation Matrix)**

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

S-Strong, M-Medium, W-Weak

**Level of Correlation between PSO's and CO's**

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

**11.1.12 LONGITUDINAL DATA ANALYSIS**

Title of the Course		LONGITUDINAL DATA ANALYSIS					
Paper Number		XII					
Category	CC	Year	II	Credits	4	Course Code	23UPBST2C12
		Semester	IV				
Instructional Hours per week	Lecture		Tutorial		Lab Practice	Total	
	4		1		--	5	
Pre-requisite		Undergraduate level Mathematics.					

<b>Objectives of the Course</b>	<ol style="list-style-type: none"> <li>1. To provide theoretical knowledge on the concept of longitudinal studies and its usage.</li> <li>2. To educate the knowledge on the Exploratory Data Analysis</li> <li>3. To acquire the knowledge on deriving its characteristics of Correlation and Regression.</li> <li>4. To provide the knowledge of different approaches to Analysis with Missing Data.</li> </ol>	
<b>Course Outline</b>	<p><b>UNIT I:</b> Definition- Benefits of longitudinal studies- Challenges of longitudinal studies with Examples- Derived Variable Analysis- Average or Slope Analysis.</p> <p><b>UNIT II:</b> Exploratory Data Analysis- Group means over time- Variation among individuals- Characterizing correlation and covariance.</p> <p><b>UNIT III:</b> Derived Variable Analysis- Pre/Post Analysis- Impact of Correlation on Inference- Common Types of Within-subject Correlation- Variance Inflation Factor.</p> <p><b>UNIT IV:</b> Regression Methods -Mixed Models with Examples- Generalized Estimating Equations (GEE).</p> <p><b>UNIT V:</b> Missing Data- Classification of Missing Data Mechanisms- Approaches to Analysis with Missing Data- Non-linear mixed models- Models for survival and repeated measurements- Models for time-dependent covariates.</p>	
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)</p>	
<b>Skills acquired from this course</b>	<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>	
<b>Recommended Text</b>	<ol style="list-style-type: none"> <li>1. Chapman and Hall, London, UK. Coletti A.S., Heagerty P.J., Sheon A.R., Gross M., Koblin B.A., Metzger D.S., Seage G.R. [2003]. Randomized, controlled evaluation of a prototype informed consent process for HIV vaccine efficacy trials. <i>Journal of Acquired Immune Deficiency Syndrome</i>, 32: 161–169.</li> <li>2. Crowder, M.J., and Hand, D.J. [1990]. <i>Analysis of Repeated Measures</i>.</li> <li>3. Chapman and Hall, New York, NY. Diggle P.J., Heagerty P.J., Liang K.-Y., and Zeger S.L. [2002]. <i>Analysis of Longitudinal Data</i>. Oxford University Press, Oxford, UK.</li> </ol>	
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Brown, H., and Prescott, R. [1999]. <i>Applied Mixed Models in Medicine</i>.</li> <li>2. Wiley, New York, NY. Carlin B.P. and Louis T.A. [1996]. <i>Bayes and Empirical Bayes Methods for Data Analysis</i>.</li> </ol>	

**Course Learning Outcome (for Mapping with POs and PSOs)**

After successfully completing the course, a student should be able to demonstrate ...

1. Understanding Longitudinal Data thinking.  
2. Understanding and implementing

Longitudinal Data Analysis.

3. Understanding various Longitudinal Data Analysis approach in several practical situation and evaluate its results.
4. Students will learn about models of Non-linear mixed and time-dependent covariates.

**CO-PO Mapping (Course Articulation Matrix)**

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

**S-Strong, M-Medium, W-Weak**

**Level of Correlation between PSO's and CO's**

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

## 11.2 Elective courses (Discipline Specific)

### Semester I: Elective I and Elective II

Elective I to be chosen from Group A and Elective II to be chosen from Group B

#### Group A:

### 11.2.1 GROUP A 1 - BASIC EPIDEMIOLOGY

<b>Title of the Course</b>		<b>Basic Epidemiology</b>					
<b>Paper Number</b>		<b>A1</b>					
<b>Category</b>	<b>ED</b>	<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>	<b>Course Code</b>	23UPBST2E01
		<b>Semester</b>	<b>I</b>				
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		4	1	-	5		
<b>Pre-requisite</b>		Undergraduate level Demography					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. Explain the role of epidemiology in the field of public health.</li> <li>2. Describe and calculate epidemiological measures used to define and quantify health problems in and across defined populations.</li> <li>3. Describe the range of epidemiologic study designs used to examine the health status of a population and be able to evaluate the strengths and limitations of each.</li> <li>4. Understand and apply epidemiological criteria needed to establish causal relationships.</li> <li>5. Understand and apply key ethical issues to the conduct of epidemiological and other scientific investigations.</li> </ol>					
<b>Course Outline</b>		<b>UNIT I:</b> Measures of disease frequency: Mortality/Morbidity rates-incidence rates prevalence rates - Source of mortality morbidity statistics-hospital records - vital statistics records- Measures of accuracy or validity: sensitivity index - specificity index- Measure of Reliability.					
		<b>UNIT II:</b> Epidemiologic concepts of diseases: Factors which determine the occurrence of diseases - models of transmission of infection - incubation period – disease spectrum and herd immunity.					
		<b>UNIT III:</b> Observational studies in Epidemiology: Retrospective (case control) and prospective (cohort or longitudinal) studies - Measures of association: Relative risk, odds ratio, attributable risk- Statistical techniques used in analysis: Cornfield and Garts method - Mantel-Haenszel method- Conditional and unconditional matching - Analysis of data from matched samples, logistic regression approach.					
		<b>UNIT IV:</b> Experimental Epidemiology: Clinical & community trials – Statistical Techniques: Methods for comparison of two treatments - Crossover design with Garts and McNemars test - Randomization in a clinical trial – sequential methods in clinical trials - clinical life tables - assessment of survivability in clinical trials.					



	<b>UNIT V: Mathematical Modeling in Epidemiology:</b> (deterministic and stochastic) simple epidemic model - generalized epidemic model- Reed-Frost and Green-wood models - models for carrier borne and host vector diseases - Estimation of latent and infectious periods - geographical spread of the disease - simulation of an epidemic.
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Roger D. Peng Francesca Dominici, (2008), Statistical Methods for Environmental Epidemiology with R, Springer.</li> <li>2. David G. Kleinbaum, Mitchel Klein (2002). Logistic regression- A selflearning approach- Springer.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Armitage. (1980). Sequential medical trials, Charles C. Thomas</li> <li>2. Bailey, N.T.J. (1987). The Biomathematics of Malaria. Oxford University Press, Incorporated.</li> <li>3. Fleiss, J.L. (1981): Statistical Methods for Rates and Proportions. John Wiley &amp; Sons, Incorporated, New York.</li> <li>4. Franeuthal. (1980). Mathematical Modernization in Epidemiology, Springer Verlag.</li> <li>5. Gross and Clark. (1989). Survival Distributions- Reliability Application in Biomedical Sciences, University Microfilms.</li> <li>6. Kahn, H.A. and C.T. Sempos. (2007). Statistical Methods in Epidemiology (Second Edition). Oxford University press, N.Y.</li> <li>7. Kahn, H.A. (1983): An introduction to Epidemiologic methods. Oxford University press, N.Y. (Digitized 2007).</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

1. Understand and discuss population based perspective to examine disease and health-related events.
2. Discuss the ethical issues in epidemiological research.
3. Learn the basic concepts of screening and outbreak investigations.
4. Critically review published epidemiological studies.
5. Understand the basic epidemiological methods and study designs.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

### 11.2.2 GROUP A 2 - STATISTICAL GENETICS

Title of the Course		Statistical Genetics					
Paper Number		A2					
Category	ED	Year	I	Credits	3	Course Code	23UPBST2E02
		Semester	I				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	1	--	5		
Pre-requisite		Undergraduate level Mathematics.					
Objectives of the Course		<ol style="list-style-type: none"> <li>To provide theoretical knowledge on the concept of Genetic Counseling in Clinical Genetics and its usage.</li> <li>To educate the knowledge of Laws of Inheritance</li> <li>Demonstrate the fundamental knowledge of Statistical genetics.</li> </ol>					
Course Outline		<p><b>UNIT I:</b> Genetic Counseling: History taking, Examination, Genetic Counseling in Clinical Genetics, Determining Recurrence Risks, Population Screening for Genetic Diseases, Reproductive decision making Model systems in genetic analysis.</p> <p><b>UNIT II:</b> Laws of Inheritance: Mendel's Law of Dominance, segregation and Independent assortment. Test cross, Back cross, Co-dominance, Incomplete dominance, Allelic Interaction, multiple allele, Linkage and Crossing Over with suitable examples, Gene mapping in Prokaryotes and Eukaryotes, Complementation test.</p>					

	<p><b>UNIT III:</b> Structure of Sex Chromosomes, Sex linked Inheritance: Complete and incompletely sex linked genes. Inheritance of XY linked genes, Y linked genes, X linked genes, Sex limited and Sex influence gene. Quantitative inheritance: Concept, Genes and Environment: heritability, Penetrance and expressivity.</p> <p><b>UNIT IV:</b> Restricted Selection Index: Variance Component and Linear Regression Approach for Analysis of Genetic Engineering Interactions – Measurement of Stability and Adaptability for Genotypes – Concepts of General and Specific Combining Ability – Diallel and Partial Diallel Crosses – Construction and Analysis.</p> <p><b>UNIT V:</b> DNA Repair: Base excision repair (BER), Nucleotide excision repair (NER), Mismatch repair (MMR), Homologous recombination (HR), Nonhomologous end joining (NHEJ), Photo reactivation and Dark repair.</p>
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government.</p> <p>(To be discussed during the Tutorial hour)</p>
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Concepts of Genetics- Klug W. S. And Cummings M. R Prentice-Hall</li> <li>2. Genetics-a Conceptual Approach Pierce B. A. Freeman</li> <li>3. Genetics- Analysis of Genes and Genomes Hartle D. L. And Jones E. W. Jones &amp; Bartlett</li> <li>4. An Introduction to Genetic Analysis- Griffith A. F. et al Freeman</li> <li>5. Principles of Genetics -Snustad D. P. And Simmons M. J. John Wiley &amp; Sons.</li> <li>6. Genetics- Strickberger M. W. Prentice-Hall</li> <li>7. Genetics - B.D.Singh</li> <li>8. Genetics - Verma&amp;Agrawal</li> <li>9. Genetics - P.K.Gupta</li> <li>10. Peter Snustad and Michael J Simmons (2009). Principles of Human Genetics.</li> </ol>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To apply basics level of Genetics concept.
2. To provide a knowledge about decision making
3. Students can understand the key statistical components involved in the planning and conduct of Genetics concept.
4. To calculate and analyze the DNA Repair.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

### 11.2.3 Group B1: OFFICIAL STATISTICS

Title of the Course		Official Statistics					
Paper Number		B 1					
Category	ED	Year	I	Credits	3	Course Code	23UPBST2E03
		Semester	II				
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		4		1	--	5	
Pre-requisite		Probability Theory					
Objectives of the Course		<ol style="list-style-type: none"> <li>1. Understanding the functioning of official statistics.</li> <li>2. Students will become familiar with institutional, legal and organizational bases, and principles of functioning in official statistics.</li> <li>3. They will understand the fundamentals of measurement in official statistics.</li> <li>4. To overcome the limitations that arises from measurement and processes of statistical production.</li> <li>5. Learn the methodological bases of measurement in official</li> </ol>					

	statistics.
<b>Course Outline</b>	<b>UNIT I:</b> Introduction to NSSO, ISS and SSO: Introduction to Indian and International statistical systems - Role, function and activities of Central and State Statistical Organizations - Organization of large scale 42 sample surveys - Role of National Sample Survey Organization - General and special data dissemination systems.
	<b>UNIT II:</b> Census of India and other countries: Population growth in developed and developing countries - Evaluation of performance of family welfare programmes - Projections of labour force and manpower - Scope and content of population census of India.
	<b>UNIT III:</b> Agricultural and Economic Statistics: System of collection of Agricultural Statistics - Crop forecasting and estimation - Productivity, fragmentation of holdings - Support prices - Buffer stocks - Impact of irrigation projects.
	<b>UNIT IV:</b> Educational and other Social statistics: Statistics related to industries - Foreign trade - Balance of payment - Cost of living - Inflation - Educational and other social statistics.
	<b>UNIT V:</b> Indian official statistics: Indian official statistics : Present official statistical system in India - Methods of collection of official statistics, their reliability and limitations - Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications - Banking and finance - Various official agencies responsible for data collection and their main functions.
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text</b>	1. Basic Statistics Relating to the Indian Economy (CSO) 1990. 2. Family Welfare Yearbook. Annual Publication of D/o Family Welfare.
<b>Reference Books</b>	1. Guide to Official Statistics (CSO) 1999. 2. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Government Publications. 3. Panse, V. G., Estimation of Crop Yields (FAO). 4. Principles and accommodation of National Population Censuses, UNESCO. 5. Statistical System in India (CSO) 1995.
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Outcomes

After successfully completing the course, a student should be able to demonstrate...

1. The legal and ethical constraints on organisations producing official statistics.
2. The principal methods for data collection, analysis and interpretation of health, social and economic.
3. The methods for presenting and preparing commentaries on official statistics.
4. Data including spatial data.
5. The Key aspects of official Statistics, as distinct from other branches of statistics.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

### 11.2.4 Group B2: POPULATION STUDIES

<b>Title of the Course</b>		<b>Population Studies</b>					
<b>Paper Number</b>		<b>B2</b>					
<b>Category</b>	ED	<b>Year</b>	I	<b>Credits</b>	3	<b>Course Code</b>	23UPBST2E04
		<b>Semester</b>	I				
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		4	1	-	5		
<b>Pre-requisite</b>		Undergraduate level Vital Statistics concepts.					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. This course aims to provide students with basic knowledge on the determinants of population.</li> <li>2. The course will also help in studying Population growth and population projection.</li> <li>3. This course will provide complete knowledge on calculations and ratios of fertility and mortality.</li> <li>4. To know the importance of migrations in population studies.</li> </ol>					
<b>Course Outline</b>		<b>UNIT I:</b> Sample Registration System, Coverage and content errors in demographic data, Chandrasekharan - Deming formula to check completeness of registration data - Methods of population projections. Inter – censal / Post – censal estimates of population. Population transition theory.					
		<b>UNIT II:</b> Measures of fertility; stochastic models for reproduction, distributions of time of birth, inter- live birth intervals and of number of births, estimation of parameters; estimation of parity progression from open birth interval data.					
		<b>UNIT III:</b> Measures of Mortality; construction of abridged life tables, infant mortality rate and its adjustments, model life table. Human Development Index - Implications of population growth on food supply, water, sanitation, housing, employment, health, education. Ecological balance and its maintenance.					
		<b>UNIT IV:</b> Population, Development and Environment Inter - relationship between population growth, environment and sustainable development with special reference to India. Human Development Index - Implications of population growth on food supply, water, sanitation, housing, employment, health, education. Ecological balance and its maintenance.					
		<b>UNIT V:</b> Population Policies and Programs Population policies in the context of growth, structure, distribution and quality of life Policies related to medical termination of pregnancy (MTP), age at marriage, sex determination tests. National and State population policies in India. Evolution of Family Welfare Program in India. Program components and organization at different levels (Nation, State, District). Goals and achievements of the Family Welfare Program - Methods of Program Impact Assessment - Impact					

	Assessment.
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text</b>	1. Kumar, R. (1986): Technical Demography, Wiley Eastern Ltd. 2. Benjamin, B. (1969): Demographic Analysis, George, Allen and Unwin.
<b>Reference Books</b>	1. Cox, P.R. (1970): Demography, Cambridge University Press. 2. Keyfitz, N. (1977): Introduction to the Mathematics of Population-with Revisions, Addison-Wesley, London. 3. Spiegelman, M. (1969): Introduction to Demographic Analysis, Harvard University Press. 4. Wolfenden, H.H. (1954): Population Statistics and Their Compilation, Am Actuarial Society.
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Learn about different methods of demographic data collection and related errors.
2. Learn about the fertility/ mortality models.
3. Understand Life Tables and their construction.
4. Learn about the theory of stable population, population projection and about the concept of migration theory.
5. To explore various aspects of the population policy and to study its impact on socio economic issues

### CO-PO Mapping (Course Articulation Matrix)

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



S-Strong, M-Medium, W-Weak

**Level of Correlation between PSO's and CO's**

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

**11.2.5 Group C1: TIME SERIES ANALYSIS**

Title of the Course		Time Series Analysis					
Paper Number		C1					
Category	ED	Year	I	Credits	3	Course Code	23UPBST2E05
		Semester	II				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		3	1	-	4		
Pre-requisite		UG Level Time Series Modelling					
Objectives of the Course		<ol style="list-style-type: none"> <li>1. Understanding of various components of time series and forecasting univariate time series</li> <li>2. Apply different methods for fitting time series models</li> <li>3. Understanding various important concepts in forecasting and smoothing methods</li> <li>4. Understanding stationary and non-stationary nature of time series data</li> </ol>					
Course Outline		<p><b>UNIT I:</b> Time Series – Introduction – components of time series – stationary and non-stationary time series - differencing method to convert non stationary series – concept of co integration.</p> <p><b>UNIT II:</b> Standard statistical measures for Time Series analysis: Absolute measures – Mean absolute error, Mean error, Mean square error. Relative measures – Percentage error, Mean percentage error, Mean absolute percentage error.</p> <p><b>UNIT III:</b> Smoothing methods – Single exponential smoothing. Double exponential smoothing (Holtmethod). Triple exponential smoothing (Holt-Winter’s method).</p>					

	<p><b>UNIT IV:</b> Decomposition method: Additive and Multiplicative decomposition – Forecast and Confidence Intervals – Kruskal-Wallis test for seasonality - Moving average Forecasting – Spencer’s and Henderson’s moving averages (without derivation). Stationary and Non-stationary Time series- Autocorrelation function (ACF) and Partial Autocorrelation function (PACF)- Portmanteau tests: Ljung–Box test and Box–Pierce test.</p>
	<p><b>UNIT V:</b> ARIMA models: Random model ARIMA (0,0,0), Non-Stationary Random model, ARIMA (0,1,0), Stationary Auto Regressive model of order one-ARIMA (1,0,0). Stationary Moving average model of order one-ARIMA (0,0,1).-A Simple Mixed model ARIMA (1,0,1), ARIMA (1,1,1).-Seasonal Time series ARIMA(p,d,q) (P, D,Q) with ARIMA (0,1,1)(0,1,1), ARCH and GARCH models: Description and properties of these models (Without proof).</p>
<p>Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)</p>	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)</p>
<p>Skills acquired from this course</p>	<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>
<p><b>Recommended Text Books</b></p>	<ol style="list-style-type: none"> <li>1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, third edition, John Wiley and Sons, Inc.</li> <li>2. Draper, N.R. and Smith, H. (2000) : Applied Regression Analysis, 2nd edition, John Wiley &amp; Sons.</li> <li>3. Spyros Makridakis, Steven C. Wheelwright and Victor E. McGee (2012), Forecasting Methods and Applications – Second Edition, John Wiley &amp; Sons.</li> <li>4. T.M.J.A. Cooray (2008): Applied Time Series Analysis and Forecasting, NAROSA publishing house Pvt.Ltd</li> <li>5. Box, G.E., Jenkins, G.M. and Reinsel, G.C. (2013) Time Series Analysis: Forecasting and Control. 4th Edition, John Wiley &amp; Sons, Hoboken, 746 p.</li> </ol>
<p><b>Reference Books</b></p>	<ol style="list-style-type: none"> <li>1. Chatterjee S. and Betram Price (1977): Regression Analysis by Examples, John Wiley &amp; Sons.</li> <li>2. George E.P. Box and Gwilym M. Jenkins (1976): Time Series Analysis – Forecasting and Control, Holdne – Day Inc.</li> <li>3. Johnston J. (1984) : Econometric Methods, (3rd Edition), McGraw Hill International Book Company, New Delhi.</li> <li>4. Singh, Parashar and Singh (1997): Econometrics and Mathematical Economics (1st Edition), S. Chand &amp; Co, New Delhi.</li> </ol>

<b>Website and e-Learning Source</b>	1. <a href="http://mathforum.org">http://mathforum.org</a> , <a href="http://ocw.mit.edu/ocwweb/Mathematics">http://ocw.mit.edu/ocwweb/Mathematics</a> , 2. <a href="http://www.opensource.org">http://www.opensource.org</a> , <a href="http://www.mathpages.com">www.mathpages.com</a>
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### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Structuring the time series data based on seasonal and non-seasonal nature.
2. Identifying the stationarity of the time series
3. Modelling time series using exponential methods and Box-Jenkins model
4. Fitting time series model and evaluating goodness of fit
5. Fitting types of ARIMA Models.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

### 11.2.6 Group C2: Machine Learning Techniques

Title of the Course		Machine Learning Techniques					
Paper Number		C2					
Category	ED	Year	I	Credits	3	Course Code	23UPBST2E06
		Semester	II				
Instructional Hours		Lecture	Tutorial	Lab Practice	Total		

per week	3	1	--	4
<b>Pre-requisite</b>	UG level Programming skill, Regression analysis			
<b>Objectives of the Course</b>	<ol style="list-style-type: none"> <li>1. Acquire theoretical knowledge on setting hypothesis for pattern recognition.</li> <li>2. Apply suitable machine learning techniques for data handling and to gain knowledge from it.</li> <li>3. Evaluate the performance of algorithms and to provide solution for various real-world applications.</li> </ol>			
<b>Course Outline</b>	<p><b>UNIT I:</b> Data types – Measures of similarity and dissimilarity – Hierarchical Clustering Methods – k-means and k-medoids clustering methods – Clustering Validity measures.</p> <p><b>UNIT II:</b> Fuzzy c-means – Fuzzy Clustering Validity Measures – Decision Trees – Building a decision tree – Tree induction algorithm – Splitting of nodes based on information gain and Gini index - Nearest Neighbor classifiers – kNN algorithm – Naïve Bayesian classifier.</p> <p><b>UNIT III:</b> Association rules mining – Basics – Apriori algorithm – Pruning and candidate generation – Rule mining. Machine learning – Introduction - Examples of various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces, PAC Learning, VC Dimension.</p> <p><b>UNIT IV:</b> Learning a Class from Examples, Linear, Non-linear, Multi-class and Multi-label classification, Decision Trees: ID3, Classification and Regression Trees (CART), Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Support vector machines: Linear and Non- Linear, Kernel Functions, K-Nearest Neighbors</p> <p><b>UNIT V:</b> Ensemble Learning Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Bayesian Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Mining Frequent Patterns.</p>			

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text</b>	<ol style="list-style-type: none"> <li>Tan, T., Steinbach, M. and Kumar, V. (2006): Introduction to Data Mining, Pearson Education. Gupta, G.K. (2008): Introduction to Data Mining with case studies, Prentice – Hall of India Pvt. Ltd. Daniel T. Larose (2006): Data Mining: Methods and Models, John Wiley and Sons.</li> <li>Han, J. and Kamber, M. (2006): Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publishers.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>Paolo Gludici (2003): Applied Data Mining: Statistical Methods for Business and Industry, John Wiley and sons.</li> <li>Rajan Chattamvelli (2009): Data Mining Methods, Narosa Publishing House, New Delhi.</li> <li>Wayne, W. David (1987) : A foundation for analysis in Health Sciences 4th ed., John Wiley &amp; Sons. Jerrold H. Zar (1984) : Bio statistical analysis, Prentice hall 2nd ed.</li> <li>Susan Milton, J. (1992) : Statistical methods in the biological and health sciences, McGraw Hill. Jain, J.R. (1982) : Statistical techniques in quantitative genetics, Tata McGraw Hill.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

- Recognize the characteristics of machine learning strategies.
- Apply various supervised learning methods to appropriate problems.
- Identify and integrate more than one technique to enhance the performance of learning.
- Create probabilistic and unsupervised learning models for handling unknown pattern
- Analyze the co-occurrence of data to find interesting frequent patterns.

### CO-PO Mapping (Course Articulation Matrix)

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

CO4	S	S	S	S	S	S	S	S	M	M
CO5	S	M	S	S	S	S	S	M	M	S

**S-Strong, M-Medium, W-Weak**

**Level of Correlation between PSO's and CO's**

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

**11.2.7 Group D1: STOCHASTIC PROCESS**

<b>Title of the Course</b>		<b>Stochastic Process</b>					
<b>Paper Number</b>		<b>D1</b>					
<b>Category</b>	ED	<b>Year</b>	I	<b>Credits</b>	3	<b>Course Code</b>	23UPBST2E07
		<b>Semester</b>	II				
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	<b>Total</b>
		2		1		-	3
<b>Pre-requisite</b>		Probability theory and Distribution theory					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>To expose the basic concepts of the theory of stochastic processes and develops the mathematical theory of random processes.</li> <li>To understand the applications of Stochastic Process as a Mathematical tool.</li> <li>To describe the advanced topics related to continuous and discrete time random processes.</li> </ol>					
<b>Course Outline</b>		<b>UNIT I:</b> Definition of Stochastic process – Specification of Stochastic Processes. Stationary Processes – Second order process, Stationarity, Gaussian processes. Martingales: Definition and properties. Martingales in discrete time - Supermartingales and submartingales - Continuous Parameter Martingales- Martingale convergence theorem and its applications					

	<p><b>UNIT II:</b> Markov chains – Definitions and examples. Higher order transition probabilities: Chapman – Kolmogrov equation. Classification of States and Chains – Determination of Higher Order Transition Probabilities -Aperiodic Chain: Limiting Behaviour. Stability of a Markov system.</p> <p><b>UNIT III:</b> Poisson process – Poisson process and related distributions. Pure Birth Process – Birth and Death process – Simple examples. Branching process – properties of generating function of branching process – Probability of extinction – fundamental theorem of branching process.</p> <p><b>UNIT IV:</b> Renewal theory - Renewal equation - Stopping time - Wald's equation - Elementary renewal theorem and its applications - Renewal reward processes - Residual and Excess life times - Markov renewal and Semi Markov processes</p> <p><b>UNIT V:</b> Queuing model M/M/1: Steady State Behaviour - Steady State Solution, Waiting time distribution. Queuing Model M/M/S - Steady State Solution, Waiting time distributions – simple problem.</p>
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Medhi, J. (2017): Stochastic Processes, New Age International Publishing Limited, New Delhi. (Reprint 2002).</li> <li>2. Karlin, S. and Taylor H.M. (1996): First Course in Stochastic Process, Academic Press.</li> <li>3. Cox. D.R and Muller (1984) The Theory of Stochastic Process Chapman &amp; Hall/crc, Boca Raton London New York.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Prabhu. N.U. (1965) : Stochastic Process, Macmillan, New York.</li> <li>2. Ross, S.M (1996): Stochastic Processes, 2nd Edition, John Wiley &amp; Sons, New Delhi.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To equip their knowledge with theoretical and practical skills which are necessary for the analysis of stochastic dynamical system in economic, financial mathematics, engineering, business and other fields.

2. To attain knowledge about stochastic process in the time domain such as Markov processes with a discrete state space, including Markov chains, Poisson processes and birth and death processes.
3. To demonstrate the specific applications to Poisson and Gaussian processes.
4. To carry out derivations involving conditional probability distributions and conditional expectations.
5. To define basic concepts from the theory of Markov chains and present proofs for the most important theorems.

#### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

#### Level of Correlation between PSO's and CO's

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

#### 11.2.8 Group D2: STATISTICAL COMPUTATIONS USING PYTHON

Title of the Course		STATISTICAL COMPUTATIONS USING PYTHON					
Paper Number		D2					
Category	ED	Year	I	Credits	3	Course Code	23UPBST2E08
		Semester	II				
Instructional Hours per week	Lecture		Tutorial		Lab Practice	Total	
	2		1		--	3	
Pre-requisite		Basics concepts of data analysis using Python					



<b>Objectives of the Course</b>	<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. To understand the basic programming principles of Python language</li> <li>2. To be familiar with the operations of data</li> <li>3. To analyze data which includes knowing how to import data, explore it, analyze it, learn from it, visualize it, and ultimately generate easily shareable reports.</li> <li>4. Explore and execute the machine learning concepts for real time data using Python</li> </ol>	
<b>Course Outline</b>	<p><b>UNIT I:</b> Basics of Python  Type of variables, data types, lists, control statements, functions, classes, files and exceptions.</p> <ul style="list-style-type: none"> <li>• Program to implement Functions. Program to perform Basic Operations on Sequence objects.</li> </ul>	
	<p><b>UNIT II:</b> Essential Modules in Python  Jupyter Notebook, Numpy, Scipy, Matplotlib, Pandas, mglearn</p> <ul style="list-style-type: none"> <li>• Program to perform Operations on Sequence annotation objects.</li> <li>• Program to perform Operations on Sequence Input/Output.</li> </ul> <p>Program to perform Operations on Multiple Sequence Alignment objects.</p>	
	<p><b>UNIT III:</b> Supervised Learning  Classification and Regression, k-Nearest Neighbors, k-Nearest Neighbors, Decision Trees, Neural Networks.</p>	
	<p><b>UNIT IV:</b> Unsupervised Learning - 1  Pre-processing and Scaling, Scaling training, Dimensionality Reduction, Feature Extraction, and Manifold Learning.</p>	
	<p><b>UNIT V:</b> Unsupervised Learning -2  Clustering: k- Means clustering, Agglomerative Clustering.</p>	
<p>Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)</p>	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)</p>	
<p>Skills acquired from this course</p>	<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>	
<p><b>Recommended Text</b></p>	<ol style="list-style-type: none"> <li>1. Introduction to Machine Learning with Python – A Guide for Data Scientists by Andreas C. Muller &amp; Sarah Guido (2017), O’Reilly</li> <li>2. Machine Learning in Python: Essential Techniques for Predictive Analysis by Micheal Bowles (2015), Wiley</li> <li>3. Python Crash Course: A hands-on, Project- Based Introduction to Programming by Eric Matthes (2016), no starch presshi.</li> </ol>	

<b>Reference Books</b>	1. Python for Probability, Statistics and Machine Learning (second edition) (2019) by JoseUnpingco, Springer 2. Practical Statistics for Data Scientists (second edition) (2020) by Peter Bruce, Andrew Bruce & Peter Gedeck, O'Reilly
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Understand the concepts of Python and its operations.
2. Performing the operations of Python by essential modules.
3. Evaluate supervised learning by different techniques.
4. Enumerate the process of unsupervised learning by pre-processing of data.
5. Enumerate the process of supervised learning by pre-processing of data

### CO-PO Mapping (Course Articulation Matrix)

Mapping with Programmes Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	M	S	M	S	S
CO2	S	M	M	M	M	S	M	M	S	M
CO3	S	M	S	L	S	M	M	L	M	M
CO4	M	M	S	M	S	L	L	L	S	L
CO5	S	S	M	L	L	M	S	S	S	L

\*S – Strong, M- Medium, L- Low

### Level of Correlation between PSO's and CO's

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

### 11.2.9 Group E1: RESEARCH METHODOLOGY IN STATISTICS

<b>Title of the Course</b>		<b>RESEARCH METHODOLOGY IN STATISTICS</b>					
<b>Paper Number</b>		<b>E1</b>					
<b>Category</b>	ED	<b>Year</b>	II	<b>Credits</b>	3	<b>Course Code</b>	23UPBST2E09
		<b>Semester</b>	III				
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		3	1	--	4		
<b>Pre-requisite</b>							
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. To understand the importance of Research problem in Statistics, and significance of report writing.</li> <li>2. Learning some statistical methodology for random variables.</li> <li>3. Acquiring knowledge of R software for statistical Computation.</li> </ol>					
<b>Course Outline</b>		<p><b>UNIT I:</b> Research Methodology - Concept of Research in Statistics – Identify Research Problem - Necessity of Defining the Problem-Technique Involved in Defining a Problem-Selection of Topic for Research.</p> <p><b>UNIT II:</b> Meaning of research design - Features of good design - Important concepts relating to research design - Different research designs - Significance of report writing Importance of literature survey – Reports, Thesis and assignment writing - Different steps in writing report - Layout of the research report.</p> <p><b>UNIT III:</b> Statistical Studies – Significance – Data Measurement Scales, Nominal, Ordinal, Ratio and Interval Scales – Sources of error in measurement – Tests of Measurement – Technique of Developing Measurement Tools – Scaling Technique – Likert type Scaling – Cumulative Scaling</p> <p><b>UNIT IV:</b> Simulation - Concept and Advantages of Simulation – Event type Simulation – Generation of Random Numbers – Monte-Carlo Simulation Technique – Generation of Random Numbers using uniform (0,1), Exponential, Gamma and Normal random variables – Simulation Algorithm.</p> <p><b>UNIT V:</b> R Language and its simple applications – Writing coding for the Computation of probabilities and cumulative probabilities using Binomial and Poisson models - Evaluation area and ordinate under normal distribution using R Software.</p>					
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)		<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)</p>					
<b>Skills acquired from this course</b>		<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>					

<b>Recommended Text</b>	1. Jonathan, Anderson et al. (1977). Thesis and Assignment Writing, Wiley Eastern Ltd, New York. 2. Pannerselvam, R. (2006). Research Methodology, Prentice-Hall of India Private Limited, New Delhi.
<b>Reference Books</b>	1. Kanti Swarup, Gupta, P.K., & Man Mohan. (2008). Operations Research Sultan Chand & Sons, (Publications), New Delhi. 2. Maria L.Rizzo.(2007). Statistical Computing with R, Chapman & Hall/CRC, Taylor and Francis Group. 3. Sudha.G.Purohit, Sharad.D.Gore and Shailaja R.Deshmukh.(2008). Statistics Using R, Narosa, Publishing House, New Delhi.
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Describe the necessity of defining the problems and techniques and can explain the importance of literature survey, Layout of the research report and significance of report writing.
2. Generalise the statistical studies using the data measurement scales, (nominal, ordinal, ratio and interval scales).
3. Apply the sources of error in measurement compare the scaling technique (likert type scaling ,cumulative scaling).
4. Summarize the knowledge of simulation Concept and its Advantages with respect to Simulation Algorithm and analyse the simulation techniques with random number generation.
5. Describe the R language and interpret the statistical computation. Manipulate the R coding to categorize the cumulative probabilities using Binomial and Poisson models.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3

<b>C02</b>	3	3	3	3	3
<b>C03</b>	3	3	3	3	3
<b>C04</b>	3	3	3	3	3
<b>C05</b>	3	3	3	3	3
<b>Weightage</b>	15	15	15	15	15
<b>Weighted percentage of Course Contribution to Pos</b>	3.0	3.0	3.0	3.0	3.0

### 11.2.10 Group E2: STATISTICAL QUALITY CONTROL

<b>Title of the Course</b>		<b>STATISTICAL QUALITY CONTROL</b>					
<b>Paper Number</b>		<b>E2</b>					
<b>Category</b>	<b>ED</b>	<b>Year</b>	<b>II</b>	<b>Credits</b>	3	<b>Course Code</b>	23UPBST2E10
		<b>Semester</b>	<b>III</b>				
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>	
		3		1	--	4	
<b>Pre-requisite</b>		Basics in Probability distributions, sampling, testing of hypotheses, control charts and inspection sampling plans.					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. Understand the application of statistics in industrial environment.</li> <li>2. Acquire know how on manufacturing process changes and process variability.</li> <li>3. Attain proficiency in process capability analysis,</li> <li>4. Instruct theory and practice of product control methodology.</li> <li>5. Comprehend the importance of reliability theory in industries.</li> </ol>					
<b>Course Outline</b>		<b>UNIT I:</b> Introduction - Shewhart Control Charts for $\bar{X}$ , R, $\sigma$ , np, p, c and their uses, OC and ARL of Control Charts, Control Charts based on C.V., Modified Control Charts, CUSUM procedures, use of V-mask, Derivation of ARL.					
		<b>UNIT II:</b> Decision Interval Schemes for CUSUM charts - Economic Designs of Control Charts, Pre-control, Relative Precision and Process Capability analysis and Gauge capability analysis, Multivariate Control charts and Hotelling $T^2$ .					
		<b>UNIT III:</b> Basic Concepts of Acceptance Sampling, Single, Double, Multiple and Sequential Sampling Plans for Attributes, Curtailed and Semi Curtailed Sampling - Dodge-Romig Tables-LTPD and AOQL Protection (Single Sampling Plan Only) - MIL-STD-105D.					
		<b>UNIT IV:</b> Variable Sampling: Assumptions, Single and Double Variable Sampling Plans. Application of Normal and Non-central t - Distributions in Variable Sampling - Continuous Sampling Plans: CSP-1, CSP-2 and CSP-3. Special Purpose Plans: Chain Sampling Plans, Skip-lot Plans.					

	<b>UNIT V: Quality Policy and Objective – Planning and organization for Quality – Quality Policy Deployment – Quality Function deployment – Quality Audit – Need for ISO 9000 Systems – Clauses – Documentation – Implementation – Introduction to QS 9000 – Implementation of Quality Management System - Six Sigma – Evaluation of Six Sigma.</b>
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Montgomery, D.C. (2009). Introduction to Statistical Quality Control, Sixth Edition, Wiley India, New Delhi.</li> <li>2. John T. Burr, (2004) Elementary Statistical Quality Control (Second Edition), Marcel Dekker New York.</li> <li>3. Duncan, A.J. (2003). Quality Control and Industrial Statistics, Irwin - Illinois.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>1. Grant, E.L., and Leavenworth, R.S. (2000). Statistical Quality Control, Seventh Edition, Tata McGraw Hill, New Delhi.</li> <li>2. Juran, J.M., and De Feo, J.A. (2010). Juran's Quality control Handbook – The Complete Guide to Performance Excellence, Sixth Edition, Tata McGraw-Hill, New Delhi.</li> <li>3. Mahajan, M. (2002). Statistical Quality Control, (Third Edition), Dhanpat Rai and Co., Delhi.</li> <li>4. Schilling, E. G., and Nuebauer, D.V. (2009). Acceptance Sampling in Quality Control Second Edition, CRC Press, New York.</li> <li>5. Wetherill, G.B. (1977). Sampling Inspection and Quality Control, Second Edition, Chapman and Hall, London.</li> </ol>
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

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

1. Construct control charts for large and smaller shifts in the process parameters
2. Effectively interpret the results from the control charts
3. Carry out process capability analysis
4. Adopt appropriate sampling inspection plans for given conditions
5. Find failure rate, identify failure rate distributions, compute reliability of components and systems.

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

### 11.2.11 Group F1: STATISTICAL ANALYSIS IN JASP

Title of the Course		STATISTICAL ANALYSIS IN JASP					
Paper Number		F1					
Category	ED	Year	II	Credits	2	Course Code	23UPBST2E11
		Semester	IV				
Instructional Hours per week	Lecture	Tutorial		Lab Practice		Total	
	4	--		--		4	
Pre-requisite		Basic knowledge on handling software					
Objectives of the Course		Upon successful completion of this course, the students will be able to: <ol style="list-style-type: none"> <li>1. Introduction to data science life cycle</li> <li>2. In depth knowledge of most popular machine learning techniques.</li> <li>3. Supervised and unsupervised learning techniques</li> <li>4. Real life case studies and simulated projects to sharpen your skill sets</li> <li>5. Assistance in creating a portfolio which will allow you to showcase your newly acquired skills.</li> </ol>					
Course Outline		<b>UNIT I: Introduction to JASP</b> Using the JASP Interface-files opening procedures- .csv (comma-separated values) is normally saved in Excel, and .txt (plain text) also can be saved in Excel, Sav (IBM SPSS data file), .ods (Open Document spreadsheet)					

<b>UNIT II: Descriptive statistics</b> Introduction-Describing Data Sets- Measures of central tendency - Measures of dispersion- Percentile values - Measures of distribution - Descriptive plots.	
<b>UNIT III: Comparing Two Groups</b> Comparing two independent samples- Independent T-test, Mann-Witney U test Comparing Two related groups- Paired Samples T-Test, Wilcoxon's Signed Rank Test.	
<b>UNIT IV: Comparing more than Two Groups</b> Anova Test- Kruskal-Wallis Test- Friedman's Test-chi-square test	
<b>UNIT V: Correlation and Regression</b> Correlation -Karl Pearson, Spearman, Kendall's tau. Regression-simple regression. Multiple regression and logistic regression	
Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text</b>	1. Statistical testing with Jamovi and JASP open source software Education (Statistics without Mathematics) Hardcover – Import, 15 April 2020.
<b>Reference Books</b>	1. The fast guide to statistical testing with JASP: Classical statistics for social sciences - plus Bayesian tests by <a href="#">Cole Davis</a> 2. Bayesian Statistical Analysis Using Jasp: Volume Two Bayesian Approach of <i>Statistical Analysis Using JASP Series</i> , Christopher P. Halter
<b>Website and e-Learning Source</b>	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

### Course Learning Outcome (for Mapping with POs and PSOs)

After successfully completing the course, a student should be able to demonstrate...

1. Understanding and implementing Linear Mixed Models (LMM).
2. Implementation of statistical procedures within the R environment.
3. Data manipulation - acquiring skills in flexible matrix manipulation.
4. Scripting - programming an analysis in such a way that the script can be used with minimal effort for similar datasets and analyses and for especially large datasets
5. Data visualization - learning how to create high-quality figures, especially associated with more complex analyses (e.g. three dimensional scatter plots, Trellis displays, etc.).



**CO-PO Mapping (Course Articulation Matrix)**

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

S-Strong, M-Medium, W-Weak

**Level of Correlation between PSO's and CO's**

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

**11.2.12 Group F2: NON - PARAMETRIC INFERENCE**

Title of the Course		NON - PARAMETRIC INFERENCE					
Paper Number		F2					
Category	ED	Year	II	Credits	2	Course Code	23UPBST2E12
		Semester	IV				
Instructional Hours per week		Lecture		Tutorial		Lab Practice	
		4		--		--	
Pre-requisite		Basic knowledge on handling softwares					
Objectives of the Course		Upon successful completion of this course, the students will be able to: <ol style="list-style-type: none"> <li>1. To familiarize the concepts of non- parametric tests</li> <li>2. To Characterize, compare, and contrast different non-parametric hypothesis tests.</li> <li>3. To Present and communicate, both orally and in written form, the results of statistical analyses of non-parametric data.</li> </ol>					
Course Outline		<b>UNIT I:</b> Nonparametric vs. Parametric statistical tests - Fundamental differences - Appropriate situations for use of nonparametric methods vs. parametric methods - Advantages and disadvantages of parametric tests - Power-efficiency of nonparametric tests relative to similar parametric tests.					

<p><b>UNIT II:</b> The one-sample case - Binomial test, Chi-Square test for goodness of fit, Kolmogorov -Smirnov test, runs test.</p> <p><b>UNIT III:</b> The case of two related samples – McNemar, Sign, Wilcoxon, Walsh tests - The case of two independent samples - fisher exact-probability test, Chi-Square test for independent samples, Median test, Mann-Whitney Utest, Kolmogorov-Smirnov test, Wald-Wolfowitz test.</p> <p><b>UNIT IV:</b> The case of k related samples - Cochran Q - test, Friedman two way analysis of variance by ranks. The case of k independent samples Chi Square test for k independent samples, Kruskal-Wallis one-way analysis of variance by ranks.</p> <p><b>UNIT V:</b> Nonparametric correlation - the contingency coefficient C, Spearman rank correlation, Kendall rank correlation, Kendall partial correlation coefficient - nonparametric linear regression.</p>	
<p>Extended Professional Component (is a part of internal component only, not to be included in the External Examination question paper)</p>	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)</p>
<p><b>Skills acquired from this course</b></p>	<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>
<p><b>Recommended Text</b></p>	<ol style="list-style-type: none"> <li>1. A Distribution-Free Theory of Nonparametric Regression (Springer Series in Statistics) Paperback – Import, 4 December 2010.</li> <li>2. Gibbons J.D. (1971): Nonparametric Inference, McGraw- Hill.</li> </ol>
<p><b>Reference Books</b></p>	<ol style="list-style-type: none"> <li>1. Hardle (1990): Applied Non-parametric Regression, Cambridge University Press.</li> <li>2. Hart J.D. (1997): Non-parametric Smoothing and Lack of Fit Tests, Springer Verlag.</li> <li>3. Takezawa K. (2005): Introduction to Non-parametric Regression - Wiley Series in Probability and Statistics, John Wiley and Sons.</li> </ol>
<p><b>Website and e-Learning Source</b></p>	<p>e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.</p>

### Course Learning Outcome (for Mapping with POs and PSOs)

After successfully completing the course, a student should be able to demonstrate...

1. Identify when not to use a non-parametric method.
2. Different non-parametric methods in estimation, testing, model fitting, and in analyses.
3. Summarize data using both graphical and numerical methods for use in non-parametric statistical methods.
4. Formulate, test and interpret various hypothesis tests for location, scale, and independence problems.

**CO-PO Mapping (Course Articulation Matrix)**

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

**S-Strong, M-Medium, W-Weak**

**Level of Correlation between PSO's and CO's**

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

**SKILL ENHANCEMENT COURSES  
(STATISTICS PRACTICAL)**

<b>Title of the Course</b>		<b>STATISTICS PRACTICAL – I (Based on R Programming)</b>					
<b>Paper Number</b>		<b>01</b>					
<b>Category</b>	Core Practical	<b>Year</b>	I	<b>Credits</b>	2	<b>Course Code</b>	23UPBST2L01
		<b>Semester</b>	I				
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		1	--	1	2		
<b>Pre-requisite</b>		Knowledge in Statistical Methods					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. Apply problem-solving techniques to solving real-world events.</li> <li>2. Apply key concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.</li> <li>3. Learn to determine sample size in various sampling schemes.</li> <li>4. Able to apply the unequal probability sampling such as PPSWR and PPSWOR for real life situations.</li> </ol>					
		<b>Probability and Distribution Theory</b>					
		<b>Exercise under Distribution Theory</b> <ol style="list-style-type: none"> <li>1. Sample Spaces, Events, and Model Assignment</li> <li>2. Assigning Probabilities, Counting Methods and Conditional Probability</li> <li>3. Independent Events</li> <li>4. Fitting of Binomial, Poisson, Normal Distribution</li> <li>5. Fitting of Simulations using a Discrete and Continuous Distribution</li> <li>6. Fitting of Weibull Distribution.</li> <li>7. Fitting of Bivariate Normal Distribution</li> <li>8. Fitting of Chi-square, t, F distribution</li> </ol>					
		<b>Sampling Methods</b>					
<b>Course Outline</b>		<b>Exercise under Sampling Methods</b> <ol style="list-style-type: none"> <li>1. Simple Random Sampling with and without replacement.</li> <li>2. Sampling with probabilities proportional to size.</li> <li>3. Stratified sampling</li> <li>4. Systematic sampling</li> <li>5. Probability-proportional-to-size sampling with replacement.</li> <li>6. Probability-proportional-to-size sampling without replacement.</li> <li>7. Ratio Estimation and Regression Estimation.</li> </ol>					
<b>Recommended Text</b>		<ol style="list-style-type: none"> <li>1. Lu, Y., &amp; Lohr, S. L. (2021). <i>R Companion for Sampling: Design and Analysis</i>. CRC Press.</li> <li>2. Dalgaard, P. (2008). <i>Introductory statistics with R</i>. springer publication.</li> </ol>					

	3. Kerns, G. J. (2010). <i>Introduction to probability and statistics using R</i> . Lulu. com.
<b>Reference Books</b>	1. Everitt, B. S., and Hothorn, T. (2010). <i>A Handbook of Statistical Analyses Using R</i> , Second Edition, Chapman and Hall, CRC Press. 2. Crawley, M, J. (2007). <i>The R Book</i> , John Wiley and Sons Private Ltd., NY.
<b>Website and e-Learning Source</b>	1. <a href="https://swayam.gov.in/nd1_noc19_ma33/preview">https://swayam.gov.in/nd1_noc19_ma33/preview</a> . 2. <a href="https://swayam.gov.in/nd2_aic20_sp35/preview">https://swayam.gov.in/nd2_aic20_sp35/preview</a> . 3. <a href="https://nptel.ac.in/courses/111/104/111104100/">https://nptel.ac.in/courses/111/104/111104100/</a>

<b>Title of the Course</b>		<b>STATISTICS PRACTICAL -II (Based on R Programming)</b>					
<b>Paper Number</b>		<b>02</b>					
<b>Category</b>	Core Practical II	<b>Year</b>	I	<b>Credits</b>	2	<b>Course Code</b>	23UPBST2L02
		<b>Semester</b>	II				
<b>Instructional Hours per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		1	--	1	2		
<b>Pre-requisite</b>		Knowledge in Statistical Methods					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. Identify the relation between the point estimation and interval estimation.</li> <li>2. Estimating maximum likelihood function for various measures.</li> <li>3. Enumerating the planning and the design of clinical trials</li> <li>4. Understand and apply statistical methods for the design of biomedical research and analysis of biomedical research data.</li> <li>5. Impart application of Time Series Analysis in various domains of R.</li> </ol>					
<b>Course Outline</b>		<b>Estimation theory</b>					
		<b>Exercise under Estimation theory</b>					
		<ol style="list-style-type: none"> <li>1. Point Estimation</li> <li>2. Confidence interval for mean, Difference of Means, Standard Deviations</li> <li>3. Confidence interval for Variance and Ratio of Variances.</li> <li>4. Maximum likelihood estimation</li> </ol>					
		<b>Survival Analysis</b>					
		<b>Exercise under Survival Analysis</b>					
<ol style="list-style-type: none"> <li>1. Fitting Kaplan–Meier</li> <li>2. Fitting Weibull Parametric Model</li> <li>3. Fitting Cox Regression Model</li> </ol>							
<b>Time Series Analysis</b>							

	<p><b>Exercise under Time Series Analysis</b></p> <ol style="list-style-type: none"> <li>Standard statistical measures for Time Series analysis: Absolute measures – Mean absolute error, Mean error, Mean square error. Relative measures - Percentage error, Mean percentage error, Mean absolute percentage error.</li> <li>Smoothing methods – Single exponential smoothing. Double exponential smoothing (Holt method).</li> <li>Triple exponential smoothing (Holt-Winter’s method).</li> <li>Autocorrelation function (ACF) and Partial Autocorrelation function (PACF)</li> <li>ARMA and ARIMA models</li> <li>Portmanteau tests: Ljung–Box test and Box–Pierce test.</li> </ol>
<b>Recommended Text</b>	<ol style="list-style-type: none"> <li>Kerns, G. J. (2010). <i>Introduction to probability and statistics using R</i>. Lulu. com.</li> <li>Ding-Geng (Din) Chen and Karl E. Peace (2011). <i>Clinical Trial Data Analysis Using R</i>. Taylor &amp; Francis Group.</li> <li>Quick, J.M. (2010). <i>Statistical Analysis with R</i>, Packt Publishing Ltd., UK.</li> <li>Robert H. Shumway David S. Stoffer. (2017). <i>Time series Analysis and its Applications: With R Examples</i>, Fourth Edition, Springer Nature.</li> </ol>
<b>Reference Books</b>	<ol style="list-style-type: none"> <li>Everitt, B. S., and Hothorn, T. (2010). <i>A Handbook of Statistical Analyses Using R</i>, Second Edition, Chapman and Hall, CRC Press.</li> <li>Crawley, M, J. (2007). <i>The R Book</i>, John Wiley and Sons Private Ltd., NY.</li> </ol>
<b>Website and e-Learning Source</b>	<ol style="list-style-type: none"> <li><a href="https://swayam.gov.in/nd1_noc19_ma33/preview">https://swayam.gov.in/nd1_noc19_ma33/preview</a>.</li> <li><a href="https://swayam.gov.in/nd2_aic20_sp35/preview">https://swayam.gov.in/nd2_aic20_sp35/preview</a>.</li> <li><a href="https://nptel.ac.in/courses/111/104/111104100/">https://nptel.ac.in/courses/111/104/111104100/</a></li> </ol>

<b>Title of the Course</b>		<b>STATISTICS PRACTICAL -III (Based on R Programming)</b>							
<b>Paper Number</b>		<b>03</b>							
<b>Category</b>	Core Practical III	<b>Year</b>	I	<b>Credits</b>	2	<b>Course Code</b>	23UPBST2L03		
		<b>Semester</b>	III						
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>		<b>Total</b>	
		1		--		1		2	
<b>Pre-requisite</b>		Knowledge in Statistical Methods							

<b>Objectives of the Course</b>	<ol style="list-style-type: none"> <li>1. Impart knowledge on statistical computation using real data sets.</li> <li>2. To familiarize the students in solving problems in testing of hypotheses, non-parametric tests through R software.</li> <li>3. Understand the theory through practical oriented training.</li> <li>4. The concept of Applied Regression analysis were incorporated.</li> <li>5. Write programming codes for the methods in Statistical quality control.</li> </ol>
	<b>Testing of Hypothesis</b>
<b>Course Outline</b>	<b>Exercise under Testing of Hypothesis</b> <ol style="list-style-type: none"> <li>1. <b>Most powerful test</b> - Uniformly most powerful test- Likelihood ratio test- Chi-Square Test, Sequential Probability Ratio Test – OC and ASN function.</li> <li>2. <b>Non-parametric test</b> - Chi-Square test, Wilcoxon’s Signed-Rank test, Mann-Whitney U test, Kolmogorov Smirnov test, Kruskal Wallis test, Friedman Test and Rank Correlation.</li> </ol>
	<b>Multivariate Analysis</b>
	<b>Exercise under Multivariate Analysis</b> <ol style="list-style-type: none"> <li>1. Maximum likelihood estimators of mean vector and dispersion Matrix.</li> <li>2. Test for mean vector when dispersion matrix <math>\Sigma</math> is known. Hotelling's <math>T^2</math> statistic</li> <li>3. Test for covariance matrix Principal component analysis.</li> <li>4. Canonical correlation.</li> <li>5. Discrimination and Classification problems. Factor Analysis, Cluster Analysis</li> </ol>
	<b>Applied Regression Analysis</b>
	<b>Exercise under Applied Regression Analysis</b> <ol style="list-style-type: none"> <li>1. Multiple Linear Regression</li> <li>2. Logistic Regression</li> <li>3. Polynomial regression</li> <li>4. Generalized Linear Models</li> </ol>
	<b>Statistical Quality Control</b>
	<b>Exercise under Statistical Quality Control</b> <ol style="list-style-type: none"> <li>1. Control Chart for X bar Chart</li> <li>2. Control Chart for R Chart</li> <li>3. S – Chart</li> <li>4. C-Chart</li> <li>5. P-Chart</li> <li>6. np- Control Chart</li> <li>7. U-chart</li> </ol>
<b>Recommended Text</b>	<ol style="list-style-type: none"> <li>1. M.Rajagopalan and P.Dhanavanthan., Statistical inference, PHI Learning Private Limited, New Delhi,2012).</li> <li>2. Lehman, E.L. and J.P. Romano, Testing Statistical Hypotheses, 3rd ed., Springer 2005.</li> <li>3. Gibbons, J.D. and S.Chakraborty, Nonparametric Statistical</li> </ol>

	<p>Inference, 3rd ed., Marcel Dekker, 2010.</p> <p>4. McGibney, D. P. (2023). Applied Linear Regression for Business Analytics with R: A Practical Guide to Data Science with Case Studies (Vol. 337). Springer Nature.</p> <p>5. Peihua Qiu, (2014). Introduction to Statistical Process Control, CRC Press, Taylor and Francis Group.</p>
<b>Reference Books</b>	<p>1. H. Brian, A Practical Introduction to Python Programming, Creative Commons Attribution, 2012.</p> <p>2. A. Saha, Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More! No Starch Press, 2015</p> <p>3. T. Hall, J. P. Stacey, Python 3 for absolute beginners, A press, 2010.</p>

<b>Title of the Course</b>		<b>STATISTICS PRACTICAL -IV (Based on R Programming)</b>					
<b>Paper Number</b>		<b>04</b>					
<b>Category</b>	Core Practical IV	<b>Year</b>	I	<b>Credits</b>	2	<b>Course Code</b>	23UPBST2L04
		<b>Semester</b>	IV				
<b>Instructional Hours per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	
		1		--		1	
<b>Pre-requisite</b>		Knowledge in Statistical Methods					
<b>Objectives of the Course</b>		<ol style="list-style-type: none"> <li>1. Understand the need and the objective of experimental design.</li> <li>2. Perform statistical test procedures using R software.</li> <li>3. Perform Time Series models using Python.</li> <li>4. Execute code for Regression and correlation models.</li> <li>5. Write customized program for statistical problems.</li> </ol>					
<b>Course Outline</b>		<b>Designs of Experiments using R Programming</b>					
		<b>Exercise under Designs of Experiments</b>					
		1. One way – Two way ANOVA, CRD, RBD and LSD - Confounding- $2^2$ , $2^3$ and $2^k$ Factorial Experiments - BIBD - PBIBD - Lattice Designs.					
		<b>Basic Programming using Python</b>					
		<b>Exercise under Python</b>					
		<ol style="list-style-type: none"> <li>1. Descriptive Statistics</li> <li>2. One sample t-test</li> <li>3. Paired t-test</li> <li>4. Independent sample t-test</li> <li>5. ANOVA -One way and Two way</li> <li>6. Chi-square test</li> <li>7. Analysis for Correlation</li> <li>8. Analysis for Regression</li> <li>9. Augmented Dickey Fuller test</li> </ol>					



	10. Autoregressive Moving Average Model 11. Autoregressive Integrated Moving Average Model 12. Classification and Regression 13. K-Nearest Neighbors 14. Decision trees
<b>Recommended Text</b>	1. Everitt, B. S., and Hothorn, T. (2010). A Handbook of Statistical Analyses Using R, Second Edition, Chapman and Hall/CRC Press. 2. Quick, J. M. (2010). Statistical Analysis with R, Packt Publishing Ltd., UK. 3. B.V. Vishwas and A. Patel. (2020). Hands-on-Time series Analysis with Python: From Basics to bleeding Edge Techniques. A press. 4. Thomas Haslwanter. (2016). An Introduction to Statistics with Python: with Applications in the life Sciences. Austria, Springer Nature. 5. Robert H. Shumway David S. Stoffer. (2017). Time series Analysis and its Applications: With R Examples, Fourth Edition, Springer Nature.
<b>Reference Books</b>	1. H. Brian, A Practical Introduction to Python Programming, Creative Commons Attribution, 2012. 2. A. Saha, Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More! No Starch Press, 2015 3. T. Hall, J. P. Stacey, Python 3 for absolute beginners, A press, 2010.

## NON-MAJOR ELECTIVE I - 23UPBST2N01

### NON-MAJOR ELECTIVE II (Courses offered to other Department)

<b>Title of the Course</b>		<b>Basic Statistical Methods</b>					
<b>Paper Number</b>		<b>I</b>					
<b>Category</b>	<b>NME ii</b>	<b>Year</b>	<b>II</b>	<b>Credits</b>	4	<b>Course Code</b>	<b>23UPBST2N02</b>
		<b>Semester</b>	<b>III</b>				
<b>Instructional Hours Per week</b>		<b>Lecture</b>		<b>Tutorial</b>	<b>Lab Practice</b>		<b>Total</b>
		4		--	--		4
<b>Pre-requisite</b>		Basic skills in correlation and Non parametric tests					
<b>Objectives of the Course</b>		The main objectives of this course are to: <ol style="list-style-type: none"> <li>1. Demonstrate knowledge of probability and the standard statistical distributions.</li> <li>2. Demonstrate knowledge of fixed-sample and large-sample statistical properties of point and interval estimators.</li> <li>3. Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures.</li> <li>4. Demonstrate the ability to perform complex data management and</li> </ol>					

	<p>analysis.</p> <ol style="list-style-type: none"> <li>5. Demonstrate the ability to apply linear, nonlinear and generalized linear models.</li> <li>6. Demonstrate understanding of how to design experiments and surveys for efficiency.</li> <li>7. Demonstrate knowledge of classical and repeated measures multivariate methods and computational techniques.</li> </ol>
<b>Course outline</b>	<p><b>UNIT I:</b> Definition of Statistics and its applications in various disciplines - Collection of Data - classification, Tabulation and Graphical representation of data - construction of univariate and Bivariate frequency distribution - Measures of central tendency - Measures of dispersion - coefficient of variation.</p> <p><b>UNIT II:</b> Random experiment - sample space - events - mathematical and statistical definition of probability - conditional probability – Bayes’ theorem - Random variables - Distribution functions - moments - Binomial distribution - Poisson distribution - Normal distribution and their properties.</p> <p><b>UNIT III:</b> Scatter diagram - Karl Pearson's coefficient of correlation- concurrent deviation method - coefficient of determination - Spearman's Rank correlation -Linear regression–fitting of regression lines.</p> <p><b>UNIT IV:</b> Tests of significance - hypotheses - two types’ of errors - power function - critical region - level of significance – small sample tests based on t and F distributions. Chi-square test of goodness of fit - contingency table -Test of independence of factors - Large sample tests.</p> <p><b>UNIT V:</b> Test of equality of several population means one way and two way analysis of variance - Non-parametric tests Sign, Run and Median tests - two sample rank test - Sampling and its uses, sampling methods - Simple random sampling, systematic and stratified</p>
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)</p>
<b>Skills acquired from this course</b>	<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>

<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Agarwal, B.L. (2013). Basic statistics. Anshan Publications.</li> <li>2. Sharma, J.K. (2007). Business Statistics (Second Edition). Pearson Education, New Delhi.</li> <li>3. Sokal, P.R. and Rohlf, F.J. (1969). Bio Statistics. W.H. Freeman and Co., San Francisco.</li> </ol>
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**Course Learning Outcome (for Mapping with Pos and PSOs)**

After successfully completing the course, a student should be able to demonstrate...

1. Recognize and apply some common probability distributions, and assess if underlying assumptions for the distribution seem reasonable.
2. Be able to perform basic statistical calculations and graphical analyses.
3. Analyze research questions based on statistical data, draw relevant conclusions, and be familiar with the limitations of particular statistical methods.
4. Be able to discuss and reflect upon ethical topics relevant to statistical methods

**CO-PO Mapping (Course Articulation Matrix)**

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

**S-Strong, M-Medium, W-Weak**

**Level of Correlation between PSO's and CO's**

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

<b>Title of the Course</b>		<b>Statistics for Behavioral Sciences</b>					
<b>Paper Number</b>		<b>II</b>					
<b>Category</b>	<b>NME ii</b>	<b>Year</b>	<b>II</b>	<b>Credits</b>	4	<b>Course Code</b>	23UPBST2N03
		<b>Semester</b>	<b>III</b>				
<b>Instructional Hours Per week</b>		<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>	<b>Total</b>
		4		--		-	4
<b>Pre-requisite</b>		Basic skills in basic statistics and measure of central tendency					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. Distinguish among different scales of measurement and their implications;</li> <li>2. Interpret data displayed in tables and graphically;</li> <li>3. Apply concepts of sample space and probability;</li> <li>4. Calculate measures of central tendency and variation for a given data set;</li> <li>5. Identify the standard methods of obtaining data and identify advantages and disadvantages of each.</li> </ol>					
<b>Course outline</b>		<p><b>UNIT I:</b> Nature and scope of Statistics - characteristics and limitation of Statistics - statistical investigation - preparation of questionnaire - design of sampling - simple random, stratified and systematic sampling - collection of data - primary and secondary data.</p> <p><b>UNIT II:</b> Processing and presentation of data - Classification of data - tabulation of data - Formation of frequency tables - Diagrammatic presentation of statistical data - bar diagrams - pie diagrams and pictograms - simple problems – Graphical presentation of statistical data - Histogram, frequency curves and Ogive curve-simple problems.</p> <p><b>UNIT III:</b> Measures of central tendency - mean, median, mode - simple problems - measures of dispersion - range, mean deviation, quartile deviation and standard deviation - relative measures of dispersion - simple problems.</p> <p><b>UNIT IV:</b> Concept of Skewness and Kurtosis - Karl Pearson's and Bowley's coefficients of Skewness- moments- coefficients of Skewness and Kurtosis - simple problems.</p> <p><b>UNIT V:</b> Correlation: Scatter diagram - simple correlation, Rank correlation. Regression - simple regression lines (without proof) - Tetrochoric correlation, Phi coefficient and Kendall's co-efficient - simple problems.</p>					

Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Campbell, R.C. (1989). Statistics for Biologists, Cambridge University Press, London.</li> <li>2. Garret, H. E., and Woodworth, R. S. (2006). Statistics in Psychology and Education. Cosmo Publications, New Delhi.</li> <li>3. Goon, A. M., Gupta, M. K., and Dasgupta, B. (2008). Fundamentals of Statistics, Volume-I, World Press Ltd, Calcutta.</li> <li>4. Gupta, S. C., and Kapoor, V. K. (2000). Fundamentals of Mathematical Statistics, Tenth Edition, Sultan Chand and Sons, New Delhi.</li> <li>5. Saxena, H. C. (1967). Elementary Statistics, Sultan Chand &amp; Co., New Delhi.</li> <li>6. Tate, M. W. (1964). Statistics in Education. Macmillan Co., New York. Y</li> </ol>

### Course Learning Outcome (for Mapping with Pos and PSOs)

Students who successfully complete the course should:

1. Explain the major concepts, theoretical perspectives and empirical findings in psychology
2. Evaluate the major methods of inquiry and statistical analysis in psychology
3. Discuss the ways in which diversity influences psychological processes
4. Critically analyze existing literature on a topic in psychology
5. Design research studies, including the application of statistical procedures
6. Discuss how psychological principles can be used to explain social issues, address pressing societal needs and/or inform public policy (aligns with new core and social behavioral inquiry)

### CO-PO Mapping (Course Articulation Matrix)

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

**S-Strong, M-Medium, W-Weak**

### Level of Correlation between PSO's and CO's

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

Title of the Course		Probability and Statistics for Scientists					
Paper Number		III					
Category	NME ii	Year	II	Credits	4	Course Code	23UPBST2N04
		Semester	III				
Instructional Hours Per week		Lecture	Tutorial	Lab Practice	Total		
		4	--	--	4		
Pre-requisite		Basic skills in Probability and testing					
Objectives of the Course		<p>The main objectives of this course are to:</p> <p><b>Knowledge</b></p> <ol style="list-style-type: none"> <li>1. Apply probability theory to set up tree diagrams.</li> <li>2. Apply probability theory via Bayes' Rule.</li> </ol> <p><b>Skills</b></p> <ol style="list-style-type: none"> <li>1. Able to apply the central limit theorem to sampling distribution</li> <li>2. Able to use estimation technique to determine point estimates confidence interval and sample size.</li> </ol> <p><b>Attitudes</b></p> <ol style="list-style-type: none"> <li>1. Able to solve problems independently.</li> <li>2. Able to appreciate the diversity of the applications of central limit theorem.</li> <li>3. Able to appreciate the diversity of the applications of hypothesis testing</li> </ol>					
Course outline		<p><b>UNIT I:</b>            Sample spaces – events – Probability axioms – Conditional Probability – Independent events – Baye's formula - Random Variables - Distribution functions – Marginal distributions, Conditional distribution – Stochastic Independence - Expectation – Conditional expectation and Conditional Variance. Moment generating functions – Cumulant generating functions.</p> <p><b>UNIT II:</b>            Probability distributions – Binomial, Poisson, geometric, uniform, exponential, normal, gamma, beta (generating function, Mean, variance and Simple</p>					

	<p>problems). Sampling distributions - <math>t, f</math>, Chi-square distributions- properties.</p> <p><b>UNIT III:</b> Estimation: Point estimation – Characteristics of estimation – Interval estimation – Interval estimates of Mean, Standard deviation, proportion, difference in means and ratios of standard deviations.</p> <p><b>UNIT IV:</b> Test for means, Variances &amp; attributes using the above distributions large sample tests – tests for means, variances and proportions. Analysis of Variance: One way and two way classifications – Complete Randomized blocks – Randomized Block Design and Latin Square Design (Only Problems).</p> <p><b>UNIT V:</b> Statistical quality control – Statistical basis for control charts – Control limits – Control Charts for variables and attributes – mean chart, range chart, standard deviation chart - charts for defectives, defects – <math>p, np, c</math> charts.</p>
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government.</p> <p>(To be discussed during the Tutorial hour)</p>
<b>Skills acquired from This course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Gupta, S.C., and Kapoor, V. K. (1977). Fundamentals of Mathematical Statistics, Sultan Chand &amp; Sons, New Delhi.</li> <li>2. Montgomery, D.C. (2009). Introduction to Statistical Quality Control, Sixth Edition, Wiley India, New Delhi.</li> <li>3. Montgomery, D.C., and Runger, G. C. (2010), Applied Statistics and Probability for Engineers, Fifth Edition, John Wiley &amp; Sons, New York.</li> </ol>

### Course Learning Outcome (for Mapping with Pos and PSOs)

After successfully completing the course, a student should be able to demonstrate...

1. Apply key concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.
2. Define and explain the different statistical distributions (e.g., Normal, Binomial, Poisson) and the typical phenomena that each distribution often describes.
3. Apply the basic rules and theorems in probability including Bayes's theorem and the Central Limit Theorem (CLT).
4. Define and demonstrate the concepts of estimation and properties of estimators.
5. Apply the concepts of interval estimation and confidence intervals.

**CO-PO Mapping (Course Articulation Matrix)**

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

**S-Strong, M-Medium, W-Weak**

**Level of Correlation between PSO's and CO's**

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

Title of the Course		Statistical Data Analysis using R					
Paper Number		4					
Category	NME ii	Year	II	Credits	4	Course Code	23UPBST2N05
		Semester	III				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	--	--	4		
Pre-requisite							
Objectives of the Course		Upon successful completion of this course, the students will be able to: <ol style="list-style-type: none"> <li>1. Apply R programming and understand different data sets.</li> <li>2. Apply R Programme and construct graphs, charts and descriptive statistics.</li> <li>3. Analyze the data and know probability and sampling by using R Programming</li> <li>4. Apply R Programming to test the hypothesis of the study.</li> <li>5. Predict the data and take decisions through R programming.</li> </ol>					



<b>Course Outline</b>	<b>UNIT I: Introduction to R programming:</b> What is R? - Installing R and R Studio-R Studio Overview - Working in the Console - Getting Help in R and Quitting R Studio Installing and loading packages. <b>Data structures, variables, and data types in R:</b> Creating Variables - Numeric, Character and Logical Data - Vectors - Matrix- Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values.
	<b>UNIT II: Data Visualization using R:</b> Diagrammatic representation of data - Scatter Plots - Box Plots - Scatter Plots and Pie diagram. <b>Descriptive statistics in R:</b> Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, and descriptive statistics by group.
	<b>UNIT III: Basic Probability in R:</b> Discrete Random Variables -Binomial Random Variable - Continuous Random Variables. <b>Sampling in R:</b> Types of Samples - Simple Random Sampling (SRS) - Systematic Sampling - Stratified Sampling - Cluster Sampling.
	<b>UNIT IV: Testing of Hypothesis using R:</b> T-test, Paired Test, Chi Square test, Analysis of Variance and Correlation.
	<b>UNIT V: Predictive Analytics in R:</b> linear Regression model, Non-Linear Least Square, multiple regression analysis, Logistic Regression.
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text</b>	<ol style="list-style-type: none"> <li>1. W. N. Venable, D. M. Smith (1999-2023), “An introduction to R” Version 4.3.1.</li> <li>2. Crawley, M. J. (2006), “Statistics - An introduction using R”, John Wiley, London 32.</li> <li>3. Jane M Horgan (2020), “Probability with R”, John Wiley and Sons Inc.</li> <li>4. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), “Statistics using R”, second edition. Narosa Publishing House, New Delhi.</li> <li>5. Shahababa B. (2011) , “Biostatistics with R”, Springer, New York.</li> <li>6. Braun &amp; Murdoch (2007), “A first course in statistical programming with R”, Cambridge University Press, New Delhi.</li> <li>7. G. Jay Kerns, (2010), “ Introduction to probability and Statistics Using R” first editions.</li> </ol>

### Course Learning Outcome (for Mapping with POs and PSOs)

After successfully completing the course, a student should be able to demonstrate...

1. Understanding and implementing Linear Mixed Models (LMM).
2. Implementation of statistical procedures within the R environment.
3. Data manipulation - acquiring skills in flexible matrix manipulation.
4. Scripting - programming an analysis in such a way that the script can be used with minimal effort for similar datasets and analyses and for especially large datasets
5. Data visualization - learning how to create high-quality figures, especially associated with more complex analyses (e.g. three dimensional scatter plots, Trellis displays, etc.).

### CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

### Level of Correlation between PSO's and CO's

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

<b>Title of the Course</b>		<b>Fundamentals of Human Rights</b>					
<b>Paper Number</b>		<b>HR1</b>					
<b>Category</b>	<b>Generic</b>	<b>Year</b>	<b>I</b>	<b>Credits</b>	2	<b>Course Code</b>	23UPPGC1H01
		<b>Semester</b>	<b>II</b>				
<b>Instructional Hours Per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		2	-	-	2		
<b>Pre-requisite</b>		Basic Understanding on Human Values					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. To know the importance of Human Rights.</li> <li>2. To understand the Indian Human Rights policies</li> <li>3. To understand Human Rights Movements</li> </ol>					
<b>Course outline</b>		<p><b>UNIT I: Introduction:</b> Meaning and Definitions of Human Rights – Characteristics and Importance of Human Rights – Evolution of Human Rights – Formation, Structure and Functions of the UNO - Universal Declaration of Human Rights – International Covenants – Violations of Human Rights in the Contemporary Era.</p> <p><b>UNIT II: Human Rights in India:</b> Development of Human Rights in India – Constituent Assembly and Indian Constitution – Fundamental Rights and its Classification – Directive Principles of State Policy – Fundamental Duties.</p> <p><b>UNIT III: Rights of Marginalized and other Disadvantaged People:</b> Rights of Women – Rights of Children – Rights of Differently Abled – Rights of Elderly - Rights of Scheduled Castes – Rights of Scheduled Tribes – Rights of Minorities – – Rights of Prisoners – Rights of Persons Living with HIVAIDS – Rights of LGBT.</p> <p><b>UNIT IV: Human Rights Movements:</b> Peasant Movements (Tebhaga and Telangana) – Scheduled Caste Movements (Mahar and Ad-Dharimi) – Scheduled Tribes Movements (Santhal and Munda) – Environmental Movements ( Chipko and Narmada Bachao Andolan) – Social Reform Movements (Vaikom and Self Respect).</p> <p><b>UNIT V: Redressal Mechanisms:</b> Protection of Human Rights Act, 1993 (Amendment 2019) – Structure and Functions of National and State Human Rights Commissions – National Commission for SCs – National Commission for STs – National Commission for Women – National Commission for Minorities – Characteristics and Objectives of Human Rights Education.</p>					
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)		<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government.</p> <p>(To be discussed during the Tutorial hour)</p>					

<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Sudarshanam Gankidi, Human Rights in India: Prospective and Retrospective, Rawat Publications, Jaipur, 2019.</li> <li>2. Satvinder Juss, Human Rights in India, Routledge, New Delhi, 2020.</li> <li>3. Namita Gupta, Social Justice and Human Rights in India, Rawat Publications, Jaipur, 2021.</li> <li>4. Mark Frezo, The Sociology of Human Rights, John Willy &amp; Sons, U.K. 2014.</li> <li>5. Chiranjivi J. Nirmal, Human Rights in India: Historical, Social and Political Perspectives, Oxford University Press, New York, 2000.</li> <li>6. Dr. S. Mehartaj Begum, Human Rights in India: Issues and perspectives, APH Publishing Corporation, New Delhi, 2010.</li> <li>7. Asha Kiran, The History of Human Rights, Mangalam Publications, Delhi, 2011.</li> <li>8. Bani Borgohain, Human Rights, Kanishka Publishers &amp; Distributors, New Delhi-2, 2007.</li> <li>9. Jayant Chudhary, A Textbook of Human Rights, Wisdom Press, New Delhi, 2011.</li> </ol>

### VALUE ADDED COURSE

<b>Title of the Course</b>		<b>Statistical Techniques Using Open Source Software</b>					
<b>Paper Number</b>		<b>01</b>					
<b>Category</b>	<b>VA</b>	<b>Year</b>		<b>Credits</b>	4	<b>Course Code</b>	23UPBST2V01
		<b>Semester</b>	<b>II</b>				
<b>Instructional Hours Per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>		
		3	1	-	4		
<b>Pre-requisite</b>		Basic skills in basic statistics and non parametric tests					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. Identify and utilize relevant previous work that supports their research</li> <li>2. Articulate a timely and important research question or creative objective</li> <li>3. Identify and utilize appropriate methodologies to address the research question or creative objective</li> <li>4. Meet the relevant field's standards for the responsible conduct of research, and effectively navigate challenges that arise in the research process</li> <li>5. Work collaboratively with other researchers, demonstrating effective</li> </ol>					

	<p>communication and problem-solving skills</p> <p>6. Present the research effectively in a conference setting and a written publication</p>
<b>Course outline</b>	<p><b>UNIT I:</b> Overview of R - Basic fundamentals - Installation and use of software, data editing, Importing data into R – Use of R as a calculator - Components of R console-Use of Packages</p> <p><b>UNIT II:</b> R Data types - Data management with vectors indexing, lists, factors, strings, Data frame - Arithmetic, Relational and Logical operators-Matrix operations.</p> <p><b>UNIT III:</b> Graphics and plots - creating simple graphic application for Statistical problems.</p> <p><b>UNIT IV:</b> Statistical functions for Central tendency, Variation, Skewness and Kurtosis- Correlation and Regression.</p> <p><b>UNIT V:</b> Statistical Tests - t, F, chi square - programming and illustration with examples.</p>
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	<p>Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)</p>
<b>Skills acquired from This course</b>	<p>Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</p>
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. W. N. Venable, D. M. Smith (1999-2023), “An introduction to R” Version 4.3.1.</li> <li>2. Crawley, M. J. (2006), “Statistics - An introduction using R”, John Wiley, London 32.</li> <li>3. Jane M Horgan (2020), “Probability with R”, John Wiley and Sons Inc.</li> <li>4. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), “Statistics using R”, second edition. Narosa Publishing House, New Delhi.</li> </ol>

<b>Title of the Course</b>		<b>Statistics for Researchers</b>				
<b>Paper Number</b>		<b>02</b>				
<b>Category</b>	<b>VA</b>	<b>Year</b>	<b>I</b>	<b>Credits</b>	4	<b>Course Code</b>
		<b>Semester</b>	<b>II</b>			
<b>Instructional Hours Per week</b>		<b>Lecture</b>	<b>Tutorial</b>	<b>Lab Practice</b>	<b>Total</b>	
		3	1	-	4	
<b>Pre-requisite</b>		Basic skills in basic statistics and non parametric tests				
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. Identify and utilize relevant previous work that supports their research</li> <li>2. Articulate a timely and important research question or creative objective</li> <li>3. Identify and utilize appropriate methodologies to address the research question or creative objective</li> <li>4. Meet the relevant field's standards for the responsible conduct of research, and effectively navigate challenges that arise in the research process</li> <li>5. Work collaboratively with other researchers, demonstrating effective communication and problem-solving skills</li> <li>6. Present the research effectively in a conference setting and a written publication</li> </ol>				
<b>Course outline</b>		<p><b>UNIT I:</b>  Definition of Statistics and its applications in various disciplines - Collection of Data -Classification, Tabulation and graphical representation of data-Construction of univariate and bivariate frequency distribution-measures of central tendency-measures of dispersion coefficient of variation.</p> <p><b>UNIT II:</b>  Random experiment-sample space-events-mathematical and statistical definition of probability-conditional probability - Baye's theorem - random variable - distribution function - moments - Binomial distribution - Poisson distribution - normal distribution and their properties</p> <p><b>UNIT III:</b>  Scatter diagram - Karl Pearson's coefficient of correlation - concurrent deviation method coefficient of determination - Spearman's Rank correlation - Linear regression - regression lines.</p> <p><b>UNIT IV:</b>  Tests of significance - types of hypotheses - two types of errors - critical region - level of significance, small sample tests based on t, F distribution, Chi - square test of goodness of fit, contingency table - test of independence of factors - Large sample tests.</p> <p><b>UNIT V:</b></p>				

	Test of equality of several population means, one way and two way analysis of variance. Non-parametric tests - sign, run and median tests - two sample rank test - sampling and its uses, sampling methods - unrestricted Random sampling (SRS) - Restricted Sampling (Stratified and Systematic).
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
<b>Skills acquired from This course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
<b>Recommended Text Books</b>	1. Agarwal (1980). Basic Statistics, Wiley Eastern. 2. Goon,A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Volume-I, World Press Ltd, Calcutta. 3. Gupta, S. C., and Kapoor, V. K. (2000). Fundamentals of Mathematical Statistics, Tenth Edition, Sultan Chand and Sons, New Delhi. 4. Sokal, P. R., and Rohlf, F. J. (1969). Bio Statistics, W.H. Freedom & Co, San Francisco. 5. Snedecor, G. W., and Cochran, W. G. (1967). Statistical Methods, Oxford-IBH, Pvt Co.

<b>Title of the Course</b>		<b>Computer Oriented Statistical Methods</b>					
<b>Paper Number</b>		<b>03</b>					
<b>Category</b>	<b>VA</b>	<b>Year</b>		<b>Credits</b>	4	<b>Course Code</b>	23UPBST2V03
		<b>Semester</b>					
<b>Instructional Hours Per week</b>	<b>Lecture</b>		<b>Tutorial</b>		<b>Lab Practice</b>		<b>Total</b>
<b>Pre-requisite</b>		Basic skills in correlation and regression					
<b>Objectives of the Course</b>		<p>The main objectives of this course are to:</p> <ol style="list-style-type: none"> <li>1. To learn fundamentals and concepts of statistical and optimization methods, in particular, with reference to frequency distribution and measures of central tendency, measures of dispersion, skewness and kurtosis,</li> <li>2. To solve problems on theory of probability, linear programming problems, transportation, assignment and game problems.</li> <li>3. To learn important theorems, different formulae and practical applications of these statistical and optimization methods in the field of Computer Sciences and Applications.</li> </ol>					

<b>Course outline</b>	<p><b>UNIT I:</b> Introduction to Computing - Computer Codes and Arithmetic Overview of BASIC - Sampling and Frequency Distribution - Measures of Central Tendency - Measures of Dispersion - Moments - Computation of Moments – Simple Problems.</p> <p><b>UNIT II:</b> Discrete Probability Distributions: Probability - Characteristics of Probability - Discrete Distributions - Binomial Distribution - Poisson Distribution - Hypergeometric Distribution – Properties and Numerical problems.</p> <p><b>UNIT III:</b> Curve Fitting: Linear Regression - Least Squares Fit - Nonlinear Fit - Fitting a Polynomial Function.</p> <p><b>UNIT IV:</b> Correlation : Coefficient of Correlation - Properties of Correlation Coefficient - Rank Correlation - Multiple Correlation - Partial Correlation.</p> <p><b>UNIT V:</b> Tests of Significance: Small sample and large sample tests - t Test, F Test and <math>\chi^2</math> test - ANOVA one way and two way classifications simple problems using Excel.</p>	
Extended Professional Component (is a part of internal Component only, not to be included in the External Examination Question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)	
<b>Skills acquired from this course</b>	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	
<b>Recommended Text Books</b>	<ol style="list-style-type: none"> <li>1. Balagurusamy, E. (2000): Computer Oriented Statistical and Numerical Methods, Macmillan Publishers India Limited.</li> <li>2. Enslein, K., Ralston, A., and Wilf, H.S. (1976): Statistical Methods for Digital Computers. John Wiley &amp; Sons, New York.</li> </ol>	