PERIYAR UNIVERSITY PERIYAR PALKALAI NAGAR SALEM – 636 011



DEGREE OF MASTER OF SCIENCE

CHOICE BASE CREDIT SYSTEM



SYLLABUS FOR M. Sc STATISTICS

(SEMESTER SYSTEM UNDER OBE REGULATIONS)

(For The Students Admitted From The Academic Year 2023 -2024 Onwards)

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BRANCH – II STATISTICS

1 COURSE OBJECTIVES

- > Demonstrate the ability to use Statistics skills for formulating and tackling real world problems.
- Recognize the importance of statistical modelling and computing.
- 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
- 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 Statisticsrelated 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:

Government Sector

Central Government Jobs	State Government Jobs
Indian Statistical Service (ISS)	Assistant Statistical Invigilator (Eco. and Stat. Dept.)
Senior Scientist, (CSRT)	Statistical Inspector (Eco. and Stat. Dept.)
Indian Institute of Crop Processing Technology	Assistant Director (Eco. and Stat. Dept.)
Scientist, (Indian Council of Medical Research)	Director/ Joint Director
Statistical Invigilator	Block Health Statistician
Research Officer	Additional Director – Administration & Schemes
Statistical Research Officer(RBI)	Deputy Director of Statistics
NSSO	Research and Scientific Officer
CSO	College/ University Professor
Indian Council of Agricultural Research(ICAR), etc	Statistical Officer, etc

Private Sectors

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

Future Scope

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

6 CURRICULUM DESIGN

Semester-I	С	H	Semester-II	C	H	Semester-III	С	H	Semester-IV	C	Η
1.1. Core -I	4	6	2.1. Core -IV	4	5	3.1. Core -VII	4	5	4.1. Core -XI	5	6
1.2 Core -II	4	6	2.2 Core -V	4	5	3.2 Core -VIII	4	5	4.2 Core -XII	5	6
1.3 Core -III	4	6	2.3 Core -VI	4	5	3.3 Core -IX	5	6	4.3 Project with Viva-Voce	5	6
1.4	3	5	2.4	3	4	3.4 Core - X	4	5	-		
Elective - I			Elective -III			(Industry Module)					
1.5	3	5	2.5	3	4	3.5	3	4	4.4	3	4
Elective -II			Elective -IV			Elective - V			Elective - VI		
1.6 Skill	2	2	2.6 Skill	2	2	3.6 Skill	2	2	4.5 Skill	2	4
Enhancement			Enhancement			Enhancement			Enhancement		
Course SEC-I			Course SEC-II			Course SEC-III			Course SEC-IV		
Practical - I			Practical - II			Practical - III			Practical - IV		
(Core II & III			(Core IV&VI			(Core VII&VIII			(Core XI & XII		
Based on R			Based on R			Based on R			Based on		
Programming)			Programming)	_	-	Programming)	_	_	Python)		
			2.7 NME* - I	2	3	3.7 NME* - II	2	3			
			2.8	2	2	3.8 Internship/	2	-	4.6 Professional	2	4
			Human Dights			Industrial			Competency		
			Human Rights			Activity			Skill		
									Enhancement		
									Course		
									4.7 Extension	1	-
	•								Activity		
	20	30		24	30		26	30		23	30
C - Credit H	- I	Iou	rs * No	on N	Iajo	or Elective			Total Credit F	Point	ts 93

7 COURSE STRUCTURE

Semester	Sl. No.	Course Code	Title of the Course	Contact Hrs per Week	Credit	Int. Marks	Ext. Marks	Tot. Marks
	1	23PSTCT01	Real Analysis and Linear Algebra	6	4	25	75	100
	2	23PSTCT02	Sampling Methods	6	4	25	75	100
	3	23PSTCT03	Distribution Theory	6	4	25	75	100
	4	23PSTME01/ 23PSTME02	Categorical Data Analysis/ Populations Studies	5	3	25	75	100
Ι	5	23PSTME03/ 23PSTME04/ 23PSTME05	Bayesian Inference/Statistical Quality Control/ Clinical Trials	5	3	25	75	100
	6	23PSTCP01	Practical – I* (Core II & III Based on R Programming)	2	2	40	60	100
				30	20			600
	7	23PSTCT04	Estimation Theory	5	4	25	75	100
	8	23PSTCT05	Measure and Probability Theory	5	4	25	75	100
	9	23PSTCT06	Time Series Analysis	5	4	25	75	100
	10	23PSTME06/ 23PSTME07/ 23PSTME08	Actuarial Statistics/ Simulation Analysis/ Epidemiology	4	3	25	75	100
п	11	23PSTME09/ 23PSTME10/ 23PSTME11	Survival Analysis/ Econometrics/ Applied Regression Analysis	4	3	25	75	100
	12		NME - I	3	2	25	75	100
	13	23PSTCP02	Practical – II* (Core IV & VI Based on R Programming)	2	2	40	60	100
	14	23PSTHR01	Human Rights	2	2	25	75	100
				30	24			800

Semester	Sl. No.	Course Code	Title of the Course	Contact Hrs per Week	Credit	Int. Marks	Ext. Marks	Tot. Marks
	15	23PSTCT07	Testing of Statistical Hypothesis	5	4	25	75	100
	16	23PSTCT08	Linear Models	5	4	25	75	100
ш	17	23PSTCT09	Multivariate Analysis	6	5	25	75	100
	18	23PSTCT10	Design of Experiments	5	4	25	75	100
	19	23PSTME12/ 23PSTME13	Operations Research/ Database Management System	4	3	25	75	100
			NME - II	3	2	25	75	100
	20	23PSTCP03	Practical – III* (Core VII, VIII and IX Based on Python)	2	2	40	60	100
	21		Internship	-	2	-	-	-
				30	26			700

	21	23PSTCT11	Stochastic Process	6	5	25	75	100
	22	23PSTCT12	Machine Learning Techniques	6	5	25	75	100
IV	23	23PSTCP1	Core Project with Viva-voce	6	5	40	60	100
	24	23PSTME14/ 23PSTME15	Non - Parametric Inference/ Reliability Theory	4	3	25	75	100
	25	23PSTCP04	Practical – IV* (Core XI, XII Based on Python)	4	2	40	60	100
			Training for Competitive Examinations	4	2	-	-	-
	26		Extension Activity	-	1	-	-	-
			30	23	-	-	500	
Total				93	-	-	2600	

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

INTERNSHIP

Time duration

Student who wish to claim these credits should undergo the internship for a duration of 15 days at the end of the second semester.

Eligible Agencies

The organization of internship shall be the governing body of either State or Central Government/ Quasi Government/ autonomous research body/ Finance or Banking organization/ Any official statistics of State and central governments. The Multinational companies, Data practicing agencies of private, government are also considered.

Material of internship for Assessment

Students have to submit the internship in black and white reflecting any Data Analysis activity such as Data compilation, Data processing, Data Cleansing, Data Mining, Data Analysis Planning, Statistical Data Programming, Data Modeling, Prediction, Forecasting, Database Management, Structured Query Language Programming, Database Administration, Data Security, Data Warehousing, Data Mining, Data Networking and Cloud Computing, Online Data Analytical Processing, etc.

Faculty In-charge

A faculty in-charge from the department will be allotted to such students during the second semester work allotment. Students should register themselves under one faculty in-charge by applying the request to the HOD during the beginning of second semester. The allocated faculty in charge will be the responsible for the evaluation of viva-voce examinations along with the end semester examinations of third semester.

Evaluation

The internship result will be declared in the third semester Mark sheet. The internship programme does not carry any marks. The Mark sheet will be showing the report of the guide after the viva-voce Examination as Commended or Highly Commended.

Other Information

Each Faculty in-charge may be allotted a maximum of 10 internship students. The registrations with University has to be done along with the other courses of third semester. Non registered courses are not considered for any grade of this type of non-mandatory credits.

PROJECT WORK

Objectives

The aim of the course is to initiate students to write and present a statistical report, under the supervision of a faculty, on some area of social interest. The project work will provide hands-on training to the students to deal with data emanating from some real-life situation and propel them to do well on some theory or relate it to some theoretical concepts. The project should be prepared basing on the own idea and interpretation of the student. It should not be copied from anywhere. A student has to consult his / her supervisor for the preparation of the project.

Guidelines

1. It is an individual project work offered in 4th semester with 4 credits.

2. The Project work shall be guided and supervised by a faculty member assigned in the beginning of the 4^{th} semester.

3. The project work topics are to be selected in such a way that there is enough scope to apply and demonstrate

the statistical techniques learnt in the course.

4. Report shall have the following format: Chapter I for Introduction for providing conceptual clarity, Chapter II for Review of Literature, Chapter III for Methodology, Chapter IV, V & VI for analysis and interpretations

of each objectives (Number of chapter can be reduced or increased depending upon the number of objectives),

chapter VII for findings and suggestions.

- 5. At the end of the 4th semester, before the last working day, project report should be submitted to the Department (two copies).
- 6. The project work will be assessed for 4 credits. Students have to give a seminar of their project report at the end of the 4th semester and which will be evaluated internally.
- 7. There will be viva-voce examination by an internal and an external examiner during end semester examination in 4th semester.

PROGRAMME OUTCOMES (PO) AND PROGRAMME SPECIFIC OUTCOMES (PSO)

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

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

8 CREDIT DISTRIBUTION

First Year: Semester - I

Part	Courses	Credit	Hours per Week(L/T/P)
Dort A	Core Courses 3(CC1, CC2, CC3)	12	18
Part A	Elective Course 2 (Generic / Discipline Specific) ED1, ED2	6	10
Part B	Skill Enhancement Course -SEC - Practical – I (Core II & III Based on R Programming)	2	2
		20	30

Semester-II

Part	Courses	Credit	Hours per Week(L/T/P)
Dort A	Core Courses 3(CC4, CC5, CC6)	12	15
I all A	Elective Course 2 (Generic / Discipline Specific) ED3, ED4	6	8
Part B	 (i) Skill Enhancement Course -SEC -Practical – II (Core IV & VI Based on R Programming) 	2	2
	(ii) NME - I	2	3
	(iii) Human Rights	2	2
		24	30

Second Year: Semester-III

Part	Courses	Credit	Hours per Week(L/T/P)
	3 Core Courses (CC7, CC8, CC9, CC10)	17	21
Part A	Elective Course 1 ED 5	3	4
	 (i) Skill Enhancement Course -SEC - Practical – III (Core VII, VIII & IX Based on Python) 	2	2
Part B	(ii) NME - II	2	3
	 (iii) Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours) 	2	-
		26	30

Semester-IV

Part	Courses	Credit	Hours per Week(L/T/P)
	Core Courses 2 (CC11, CC12)	10	12
Part A	Elective Course 1 (Generic / Discipline Specific) ED 6	3	4
	Project with Viva voce (CP)	5	6
Part B	Skill Enhancement Practical – IV (Core X, XI & XII Based on Python)	2	4
	Training for Competitive Examinations	2	4
Part C	Extension Activity (Can be carried out from Sem II to Sem IV)	1	-
		23	30

Component wise Credit Distribution

Credits	Sem I	Sem II	Sem III	Sem IV	Total
Part A (CC, ED, CP)	18	18	22	18	76
Part B					
(i) Discipline – Centric / Generic Skill -(SEC- Practical)	2	2	2	2	8
(ii) NME	-	2	2	-	4
(iii) Summer Internship / Industrial Training/ Human Rights	-	2	-	-	2
Part C Training for Competitive Examinations /Extension Activity	-	-	-	3	3
Total	20	24	26	23	93

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), (iii) 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.

Semester wise credit distribution

	First Year: Semester-I	Credit	Hours per week(L/T/P)
	CC1 - Real Analysis & Linear Algebra	4	6 (5L + 1T)
	CC2 - Sampling Methods	4	6 (5L + 1T)
	CC3 - Distribution Theory	4	6 (5L + 1T)
Part A	Elective I(Generic / Discipline Specific)(One from Group A)	3	5(4L + 1T)
	Elective II(Generic / Discipline Specific)(One from Group B)	3	5 (4L + 1T)
Part B	(i) Skill Enhancement Course -SEC - Practical-I(Core II &III based on R programming)	2	2
	Total	20	30

	Semester-II	Credit	Hours per week(L/T/P)
	CC4 – Estimation Theory	4	5 (4L + 1T)
	CC5 – Measure and Probability Theory	4	5 (4L + 1T)
Part A	CC6 - Time Series 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	4(3L + 1T)
	 (i) Skill Enhancement Course -SEC 2, Practical – II (Core IV & VI Based on R Programming) 	2	2
Part B	(ii) NME - I	2	3
	(iii) Human Rights	2	2
	Total	24	30

Internship during Summer Vacation of II Semester.

	Second Year: Semester-III	Credit	Hours per week(L/T/P)
	CC7 - Testing of Statistical Hypothesis	4	5 (4L + 1T)
	CC8 - Linear Models	4	5 (4L + 1T)
Part A	CC9 – Multivariate Analysis	5	6 (5L + 1T)
	CC10 Design of Experiments	4	5 (4L + 1T)
	Elective V(Generic / Discipline Specific)(One from Group E)	3	4 (3L + 1T)
Part B	 (i) Skill Enhancement Course -SEC 3 - Practical – III (Core VII, VIII & IX Based on Python) 	2	2
	(ii) NME - II	2	3
	(iii) Internship / Industrial Activity		
	(Carried out in Summer Vacation at the end of I year –	2	-
	15 days)		
	Total	26	30

The Credits shall be awarded in Semester - III Statement of Marks

	Semester-IV	Credit	Hours per week(L/T/P)
	CC11- Stochastic Process	5	6(5L + 1T)
Part A	CC12 – Machine Learning Techniques	5	6(5L+1T)
I ult II	Core Project with viva - voce	5	6
	Elective VI(Generic / Discipline Specific)(One from Group F)	3	4 (3L + 1T)
Part B	(i) Skill Enhancement Course -SEC 4- Practical – IV (Core X, XI & XII Based on Python)		4
Dont C	Training for Competitive Examinations	2	4
Extension Activity		1	-
	Total	23	30
	Over All Total Credits	93	

Consolidated Table for Credits Distribution

		Category of Courses	Credits for each Course	Numberof Courses	Number of Credits in each Category of Courses	Total Credits	Total Credits for the Programme
		Core	(4x9) +(5x3)	(5 + 7)= 12	51	74	
рарт а		Project with viva voce	5	1	5		
	(Elective Generic and Discipline Centric)	3	6	18		82 (CGPA)
PART B	i	Skill Enhance -ment(SEC) (Practical's)	2	4	8	8	
	ii	NME	2	2	4	1	
	iii	Human Rights	2	1	2	4	
		Internship	2	1	2	2	11(Non
PART C	E	Training for Competitive Examinations	2	1	2		CGPA)
		Extension Activity	1	1	1	3	
							93

Semester wise Credits Distribution

Code	Category	Title of the Paper	Ma (Max	arks x 100)	Duration	Credits	
		-	CIA	UE	IOT UE		
Semester	-I						
	Core I	Real Analysis & Linear Algebra	25	75	3 Hrs	4	
	Core II	Sampling Methods	25	75	3 Hrs	4	
	Core III	Distribution Theory	25	75	3 Hrs	4	
Part A	Elective I	Elective-I (Choose one from Group-A)	25	75	3 Hrs	3	
	Elective II	Elective-I I (Choose one from Group-B)	25	75	3 Hrs	3	
Part B (i)	Skill Enhancement Course -SEC 1	Practical – I (Core II & III Based on R Programming)	25	75	3 Hrs	2	
		Semester-II					
	Core IV	Estimation Theory	25	75	3 Hrs	4	
	Core V	Measure and Probability Theory	25	75	3 Hrs	4	
	Core VI	Time Series Analysis	25	75	3 Hrs	4	
Part A	Elective III	Elective-III (Choose one fromGroup- C)	25	75	3 Hrs	3	
	Elective IV	Elective-IV (Choose one from Group-D)	25	75	3 Hrs	3	
Part B (i)	Skill Enhancement Course -SEC 2	Practical – II (Core IV & VI Based on R Programming)	25	75	3 Hrs	2	
Part B (ii)	HR	Human Rights	25	75	3 Hrs	2	
Part B (iii)	NME - I		25	75	3 Hrs	2	

Semester	·III					
	Core VII	Testing of Statistical Hypothesis	25	75	3 Hrs	4
	Core VIII	Linear Models	25	75	3 Hrs	4
	Core IX	Multivariate Analysis	25	75	3 Hrs	5
Part A	Core X	Design of Experiments	25	75	3 Hrs	4
	Elective / ED V	Elective-VI /ED-V (Choose one from Group-E)	25	75	3 Hrs	3
(i) Part B	Skill Enhancement Course -SEC 3	Practical – III (Core VII, VIII & IX Based on Python)	25	75	3 Hrs	2
(iii)	NME - II		25	75	3 Hrs	2
(ii) Internship / Industrial - Vacation Activity					2	
Semester	ĪV					
	Core X	Stochastic Process	25	75	3 Hrs	5
	Core XI	Machine Learning Techniques	25	75	3 Hrs	5
Part A		Project with viva-voce	40	60	-	5
	Elective VI	Elective-VI (Choose one fromGroup – F)	25	75	3 Hrs	3
Part B (i)Skill Enhancement Course -SEC 4Pract XII E		Practical – IV (Core XI, XII Based on Python)	40	60	3 Hrs	2
Part C		Training for Competitive	2			
		Extension Activity				1
Total Cre	dits					93

Marks and Grades

RANGE OF	GRADE POINTS	LETTER GRADE	DESCRIPTION
MARKS			
90-100	9.0-10.0	0	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	В	Average
00-49	0.0-4.9	U	Re-appear
ABSENT	0.0	AAA	ABSENT

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

a. Semester:

GRADE POINT AVERAGE (GPA)

Sum of the multiplication of grade points by the credits of the courses

GPA = -----

Sum of the credits of the courses in a semester

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5 - 10.0	O+	
9 and above but below 9.5	0	First class with Exemplary*
8.5 and above but below 9.0	D++	
8.0 and above but below 8.5	D+	First class with Distinction*
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	
6.5and above but below 7.0	A+	First Class
6.0 and above but below 6.5	А	
5.5 and above but below 6.0	B+	
5.0 and above but below 5.5	В	Second class
0.0 and above but below 5.0	U	Re-appear

b. The Entire Programme:

CUMULATIVE GRADE POINT AVERAGE (CGPA)

CGPA = Sum of the multiplication of grade points by the credits of the entire programme 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	0	
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
6.5and 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	В	
0.0 and above but below 5.0	U	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

9 DIFFERENT TYPES OF COURSES

Core Courses CC

S. No.	Course	Title of the Course
	No.	
1	Ι	Real Analysis and Linear Algebra
2	II	Sampling Methods
3	III	Distribution Theory
4	IV	Estimation Theory
5	V	Measure and Probability Theory
6	VI	Time Series Analysis
7	VII	Testing of Statistical Hypotheses
8	VIII	Linear Models
9	IX	Multivariate Analysis
10	X	Design of Experiments
11	XI	Stochastic Process
12	XII	Machine Learning Techniques

Elective Courses ED

Group	No.		Title of the Course
А	Ι	1	Categorical Data Analysis
	II	2	Population Studies
В	III	1	Bayesian Inference
	IV	2	Statistical Quality Control
	V	3	Clinical Trials
С	VI	1	Actuarial Statistics
	VII	2	Simulation Analysis
	VIII	3	Statistical Methods for Epidemiology
D	IX	1	Survival Analysis
	Х	2	Econometrics
	XI	3	Applied Regression Analysis
E	XII	1	Operations Research
	XIII	2	Database Management Systems
F	XIV	1	Non - Parametric Inference
	XV	2	Reliability Theory

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	Ι	Practical – I (Core II and III based on R Programming)
2	II	Practical – II (Core IV and VI based on R Programming)
3	III	Practical – III (Core VII, VIII and IX based on Python)
4	IV	Practical –IV (Core X, XI based on Python)

Human Rights (Common to All)

Non- Major Elective Courses for other Departments (Not for Statistics students) NME

Students from other Departments may choose any one of the following as Non - Major Elective Course.

S. No.	Course No.	Title of the Course
1	Ι	Statistics for Life Sciences
2	II	Optimization Techniques
3	III	Statistical Methods
4	IV	Statistical Tools for Analysis

Instructions for Course Transaction

	Lecture	Tutorial	Lab Practice	Total
Courses	Hrs	Hrs		Hrs
Core (CC)	75	15		90
Electives (ED)	75	15		90
Practical's (SEC)	45	15	30	90
Project	20		70	90

10 EXAMINATION PATTERN

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

Theory Papers

Marks for Internal: (Max.Marks:25)

Internal marks distribution:				
	Cycle test and model Exam	:	15 marks	
	Assignment	:	05 marks	
	Seminar	:	05 marks	
	Total	:	25 marks	

Marks for External: (Max.Marks:75)

	Maximum 75 Marks				
	Passing Minimum: 50% Duration : Three Hours				
Intended Learning Skills	Part –A (15 x 1 = 15 Marks)				
	Answer ALL questions				
Memory Recall / Example/	Each Question carries 1 Mark				
Counter Example / Knowledge about					
the Concepts/ Understanding	Three questions from each UNIT				
	Question 1 to Question 15				
	Part – B (2 x 5 = 10 Marks)				
Descriptions/Application	Answer ANY TWO questions (internal choice)				
(problems)	Each questions carries 5 Marks				
(problems)	One question from each UNIT				
	Question 16 To Question 20				
	Part-C (5x 10 = 50 Marks)				
	Answer ALL the questions				
	Each question carries 10 Marks				
Analysis /Synthesis / Evaluation	Either - or Type				
Anarysis / Synthesis / Evaluation	Both parts of each question from the same UNIT				
	Question 21(a) or 21(b)				
	То				
	Question 25(a) or 25 (b)				

Practical papers

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

Question pattern for Practical

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

Time: 3hrs			Maximum marks: 60			
	Part – A $(3 \times 20 = 60)$					
	Answer ANY THREE out of FIVE questions					
External ma	arks distribution:					
	Write and Type the Programme	(3 X 10)	:	30 marks		
	Run the Programme	(3 X 5)	:	15 marks		
	Correct output	(3 X 5)	:	15 marks		
	Total		:	60 marks		

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 Real Analysis and Liner Algebra

Title of	the Course	rse Real Analysis and Liner Algebra						1
Pape	r Number	I						
Category	Category CC		I	Credits			Course 23PSTCT0	
Instruct	tional Haung	Locture	1	Jutorial	I oh Dro			Total
Instruc	lional Hours	Lecture			Lab Fractice		Total	
pe	r week	5		I	-			6
Pre-requis	ite	Undergrad	uate lev	el Vector A	lgebra and l	Matrix	Theo	ory
Objectives Course	of the	 To provide recollection as well as building Mathematical foundation in Real Analysis and Matrix Theory To understand concepts and definition of metric space and theorems related to it To know integration and differentiation concepts and its application, to know real functions in one variable as well as several variables, understand it on numerical problems 					building nd Matrix c ots and its ariable as numerical	
Course Ou	ıtline	 UNIT I: Metric Space – open, closed sets – Intervals (rectangles, Real valued Continuous functions- Discontinuities - compact sets Bolzano – Weirstrass theorem, Heine – Borel theorem. UNIT II: Derivatives - maxima and minima - Riemann integral & Riemann – Stieltjes integral with respect an increasing integrator properties of R.S. integral. UNIT III: Basic properties of matrices (orthogonal, idempoten Kronecker product, projection operators); Linear dependence independence and rank of a matrix; characteristic roots andpolynomia multiplicity of characteristic roots; Cayley Hamilton theorem; inverse of a matrixand determinants. UNIT IV: Reduction of matrices, Echelon form, Hermite canonicat form, diagonal reduction, rank factorization, triangular reduction lordan form 					vals (rectangles), - compact sets, mann integral & sing integrator – nal, idempotent, ar dependence, s andpolynomial, theorem; inverse ermite canonical ngular reduction	

	UNIT V: Symmetric matrices and its properties; Decomposition, singular value decomposition, spectral decomposition, Cholesky decomposition. Matrix differentiation; Generalized inverse and its properties. Applications of g- inverse- Quadratic forms
Extended Professional	
Component (is a part of	Questions related to the above topics, from various competitive
internal component only,	examinations UPSC / TRB / NET / UGC - CSIR / GATE / TNPSC /
Not to be included in the	others to be solved
External Examination	(To be discussed during the Tutorial hour)
question paper)	
Skills acquired from this	Knowledge, Problem Solving, Analytical ability, Professional
Course	Competency, Professional Communication and Transferrable Skill

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

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.2 Sampling Methods

Title of th	e Course	Sampling Methods									
Paper N	Number	II									
Category	CC	Year	Ι		Credits	4	Co	urse	23PSTCT02		
Curregory		Semester	Ι		creates	•	C	ode	201 5 1 0 1 0 2		
Instructio	nal Hours	Lectur	e]	Futorial	Lab Prac	ctice		Total		
per v	veek	5			1	-			6		
Pre-requis	ite	Undergrad	uate lev	vel S	Sampling Te	chniques					
Objectives Course	of the	1. 2. 3.	To cove To expl To unde variabil samplin	er sa lain ersta lity a ng va	ampling desi and compar and the conc and strategie ariability.	gn and anal e various sa epts of bias es for reduci	lysis n amplin and sa ngthe	nethoc ng proc amplin bias a	ls cedures. ng ind		
Course Ou	tline	UNIT I : F and system UNIT II : methods – estimators. UNIT III : and variance of mean an	Prelimin atic san PPS s Sen-M Cluster ce, optin d varian	narie npli sele lidz r Sa nun	es – Simple ng. ction metho uno samplin mpling- Equ n cluster size	Random Sa ods - PPSV ng method nal cluster sa e, Unequal	vR ar – Or amplir cluster	ng , Str nd PP dered ng – E r samp	ratified sampling, SWOR sampling and Unordered stimators of mean bling – Estimators		
		UNIT IV : Ratio Estimation – Unbiased Ratio Type estimate Regression Estimation - Double Sampling for Ratio and Regre Estimation UNIT V: Sources of errors in Surveys – A mathematical model of effects of call-backs – a mathematical model of the errors of measure Interpenetrating subsampling method									
Extended Professiona Component of component to be includ External Ex question pa	l (is a part internal only, Not led in the camination per)	Questions r examinatio applied sur department (To be disc	related t ns UPS vey tech of Tam ussed d	to th C / ' hnig hil N hurir	ne above top TRB / NET Jues adopted Jadu State G ng the Tutori	ics, from va / UGC – Cs in Econom overnment. al hour)	urious SIR / C iics an	comp GATE d Stat	etitive / TNPSC / istics		
Skills acqu this course Recommen	uired from	 Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill 1. S.Sampath (2005): Sampling Theory and Methods, Narosha Publishing House. 2. W.G. Cochran (1965): Sampling Techniques, Wiley and Son 									
Text Books	5	3.	Desraj	(19	76): Sampli	ng Theory,	McGr	aw Hi	ll, New York.		

Reference Books	 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 P.V.Sukhatme, B.V.Sukhatme, S.Sukhatme and C.Asok (1984) L Theory of Same Surveys with Applications, IASRI, New Delhi
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for this
e-Learning Source	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
CO1	S	S	М	М	М	S	М	S	М	М
CO2	S	S	S	S	М	S	М	S	М	М
CO3	S	S	М	М	S	S	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.3 Distribution Theory

Title of th	e Course	Distribution Theory									
Paper N	Number	III									
Cotogory	CC	Year		Ι	Credite	1	Co	urse	231	рстст	03
Category	cc	Semester		Ι	Creuits	4	C	ode	251 51 0105		03
Instructio	nal Hours	Lectur	re T		Sutorial	Lab Pra	ctice		Т	otal	
per v	veek	5			1	-				6	
Pre-re	quisite	Undergrad	luate	level	Distributio	n Theory.					
Objectives (Course	of the	 To provide theoretical knowledge on the concept of functions of random variables andits usage. To educate the knowledge on the both discrete and continuous distributions. To acquire the knowledge on deriving its characteristics of distributions. UNIT I: Brief review of distribution theory, functions of random variable 								riables	
Course Ou	ıtline	and their of distribution UNIT II: distribution UNIT III: F distribution UNIT IV: marginal d distribution UNIT V exponentia distribution	listrib n, log Biva ns of J Samp ions a and re cord istribu ns. : Ku il, W ns cla	ariate Binor oling and the elated ler st utions olmo Veibu ssifie	s using Jac al distribut Normal <u>mial, Poisso</u> distribution eir proper distributio atistics the s of order s gorov Sn ll and ex d by hazard	obian tran on, gamma Distributio on and Nor ns, non-cer ties, distri n theory. oir distribut tatistics, ex nirnov di streme va l rate.	sform a, loga n – mal di tral cl bution tions treme stribu	ation, writhm Comp istribu hi-squ s of q and p value tions, distrib	Laplac ic serie oound a tions. are dist uadrati properti e and th life putions	e and C s. and tru ribution c forms ies, Join eir asyn distrib Mills	Cauchy Incated In, t and Under Int and Inptotic Utions, ratio,

Extended											
Professional											
Component	Questions related to the shows tonics, from various competitive										
(is a partof internal	Questions related to the above topics, from various competitive										
component only, Not	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /										
to be included in the	others to be solved										
External	(To be discussed during the Tutorial hour)										
Examination											
question paper)											
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional										
this course	Competency, Professional Communication and Transferrable Skill										
	1. Gibbons (1971) : Non-parametric inference, Tata McGraw Hill.										
Recommended	2. Rohatgi, V.K. and Md. Whsanes Saleh, A.K.(2002): An										
Text Books	introduction to probability & Statistics, John Wiley and										
	Sons.										
	1. Rao, C.R. (1973) : Linear statistical inference and its										
	applications, 2ed, whey Eastern. 2 Mood A M & Gravbill E A and Boes D C :										
	2. Introduction to the theory of statistics McGraw Hill										
	Johnson S. & Kotz (1972): Distributions in Statistics										
Reference Rooks	Vol I II & III Hougton & Miffin										
Kelerence Dooks	3 Dudewicz F I Mishra S N (1988) · Modern mathematical										
	statistics. John Wiley. Searle, S.R.(1971) : Linear models, John										
	Wiley.										
	4. Primal Mukopadhyay (2006) Mathematical Statistics, 3 rd edition,										
	New Central Book Agency										
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for										
e-Learning Source	thissubject.										

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

- 1. To understand the knowledge on importance of the random variables and its role in the distribution theory.
- 2. To interpret the properties of special univariate continuous distributions, truncatednormal distribution and few non-central distributions.
- 3. To explain the moments for the data come from the univariate and bivariatedistributions.
- 4. To interpret the distributions of order statistics with regard to Median, Sample Rangeand Joint distribution of order two.
- 5. To identify the data distribution based on One sample and two samples using KS tests.

CO-PO Mapping (Course Articulation Matrix)

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
-	_		_			_			4

CO1	S	S	Μ	М	Μ	Μ	М	S	Μ	М
CO2	S	М	S	S	М	М	М	S	М	М
CO3	S	S	S	М	S	М	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	3.0	5.0	5.0	5.0
11.1.4 Estimation Theory

Title of the	e Course	Estimation Theory							
Paper N	umber	IV							
Cotogomy	CC	Year	Ι	Credite	4	Cours	se 23DSTCT04		
Category	u	Semester	II	Creans	4	Code	e 25151C104		
Instruction	al Hours	Lecture]	Futorial	Lab Pra	ctice	Total		
per w	veek	5		1	-		6		
Pre-req	uisite	Undergraduate level Probability Theory.							
Objectives Course	of the1.To make the students to understand the baconcepts of the statistical estimation theory. To study the properties of ideal estimators is unbiasedness, consistency, sufficiency, completeness. 3.3.To educate various estimation methods like method moments, method of maximum likelihood, inter 						stand the basic heory. estimators like completeness. ds like method of kelihood, interval		
Course Out	line	 UNIT I: Sufficient statistics, Neyman, Fisher Factorization theorem, the existence and construction of minimal sufficient statistics, Minima sufficient statistics and exponential family, sufficiency and completeness sufficiency and invariance. UNIT II: Unbiased estimation: Minimum variance unbiased estimation locally minimum variance unbiased estimators, Rao Blackwell – theorem Completeness- Lehmann Scheffe theorems, Necessary and sufficient condition for unbiased estimators. UNIT III: Cramer- Rao lower bound, Bhattacharya system of lower bounds in the 1-parameter regular case. Chapman -Robbins inequality. UNIT IV: Maximum likelihood estimators, Asymptotic Efficiency or maximum likelihood estimators, Best Asymptotically Normal estimators Method of moments. UNIT V: Bayes' and minimax estimation: The structure of Bayes' rules Bayes' estimators for quadratic and convex loss functions, minimax 							
Extended Pr Component of internal co only, Notto included in External Exa question pap	ofessional (is a part omponent be the amination per)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)							
Skills acqui	ired from	m Knowledge, Problem Solving, Analytical ability, Profession							
this course		Competence	y, Profes	ssional Com	municatio	n and Tr	ansferrable Skill		
Recommend	ded	1. V	V.K.Roh	atgi etal(20	002) : An	introduc	tion to		
Text Books		I	orobabili	ity and stat	istics, John	n Wiley.	Lehmann, E.L.		
		M Raianor	(1983): valan ang	d P Dhanas	vanthan (20	ation, JO 01200 Sta	III WIICY.		
		Learning P	vt Ltd, N	New Delhi.	antifull (20	<i>512)</i> . 5ta			

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

Students will be able to

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

CO-PO Mapping (Course Articulation Matrix)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
--	-----	-----	-----	-----	-----	-----	-----	-----	-----	------

CO1	S	S	М	Μ	Μ	S	М	S	Μ	М
CO2	S	S	S	S	М	S	М	S	М	М
CO3	S	S	S	М	S	S	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	3.0	5.0	5.0	5.0

11.1.5 Measure and Probability Theory

Title of the	e Course	Measure and Probability Theory								
Paper N	umber				V					
Category	CC	Year Semester	I II	- Credits	4	Cour Code	e 23PSTCT05			
Instruction	al Hours	Lectu	Lecture Tut		Lab Pra	ctice	Total			
per week		5		1	-		6			
Pre-req	luisite	Undergrad	uate level	I Mathematics	s, Probabil	lity and	Random Variables.			
Objectives Course	of the	1. 2. 3.	 This paper provides mathematical background for the knowledge of Probability Theoryextended from measure theoretical approach. The students will be able to understand the basic concepts of the distribution function and random variables that help in understanding for estimation and testing problems inStatistical Inference. The fundamentals of this course will pave the way for furthe research. 							
		UNIT I: F Field, Sign Measurabl UNIT II: properties, almost eve in mean.	 Field, Sigma Field and Monotone class, Measure and Measure Space – Measurable function. UNIT II: Lebesgue – Stieltjes measure, Measure integral and its properties, Dominated convergence theorem – Radon–Nikodymn theorem, almost everywhere convergence, convergencein measure and convergence in mean. 							
Course Out	line	random va variables Markov, C	random variables and random vector, Distribution functions of random variables and random vector, Expectation and Moment inequalities - Markov, Chebyshev's, Holder's, Minkowski's and Jensen's inequalities.							
		UNIT IV conditiona and their p convergen mean and Helly-Bray	Independence of sequence of events and random variables l probability, conditional expectation, Characteristic function roperties, inversion formula, convergence of random variable ce in probability, almost surely, in the r th in distribution, their relationships, convergence of moment v theorem, continuity theorem.							
		UNIT V: Central limit theorem, statement of CLT, Lindeberg, Levy Liapounov forms with proof and Lindeberg Feller's form examp Khintchine weak law of large numbers, Kolmogorovinequality, strong of large numbers.								

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional
this course	Competency, Professional Communication and Transferrable Skill
Recommended Text Books	 Bhat, B.R. (1985): Modern probability theory, 2nd ed. Wiley Eastern. Chow, Y.S. andTeicher, H. (1979): Probability theory, Springer Verlag. Chung, K.L. et al: A course inprobability theory, Academic press. Billingsley, P. (2012): Probability and Measure, John Wiley & Sons, Inc., Publication.
Reference Books	 Parthasarthy, K.R. (1977): Introduction to probability and measure, MacMillan Co.,Breiman, L. (1968): Probability, Addison Wesley. Munroe, M.E. (1971): Measure and integration, 2nd ed. Addison Wesley. Halmos, P.R.(1974): Measure theory, East-West. De Barr, G. (1987): Measure theory and integration, Wiley Eastern.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course

Students will be able to

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

CO-PO Mapping (Course Articulation Matrix)

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

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	3.0	5.0	5.0	3.0

11.1.6 Time Series Analysis

Title of th	ne Course	Time Series Analysis							
Paper N	Number	VI							
Catagory	CC	Year		Ι	Credita	1	Co	ourse	33DSTCT04
Category	tt	Semester		II	Creatis	4	C	ode	23PS1C100
Instructio	nal Hours	Lectur	e	ſ	Futorial	Lab Pra	ctice		Total
per week		5		1 - 6					
Pre-requis	ite	UG Level	Time	Serie	s Modelling				
Objectives	of the	1. Unde	erstan	ding o	of various co	omponents of	of time	e serie	s and forecasting
Course		univa	ariate	time	series	.		_	
		2. Appl	y diff	erent	methods for	fitting time	e serie	es mod	els
		3. Unde	erstan	ding v	arious impo	ortant conce	epts in	foreca	asting and
		smoo	othing	g meth	lods	1			с.: ·
		4. Unde	erstan	aing s	stationary ar	d non-statio	onary	nature	of time series
Course Out	1:00	UNIT I. Time Series Introduction components of time series							
Course Out	ime	stationary and non-stationary time series - differencing method to convert							
		non stationary series – concept of co integration.							
		UNIT II: Standard statistical measures for Time Series analysis: Absolute							
		measures -	- Det	in abs	olule error, I	Mean error,	ntage	n squa	re error. Relative
		percentage error.							
		INIT III . Smoothing methods - Single exponential smoothing. Double							
		exponential smoothing (Holtmethod). Triple exponential smoothing (Holt-							
		Winter's method).							
		UNIT IV	': D	ecom	position n	nethod: A	dditiv	e and	d Multiplicative
		decomposit	tion –	- Fore	cast and Co	nfidence In	Iterval	ls – K	ruskal-Wallis test
		for season	nality	- I	Moving av	erage For	ecasti	ng	Spencer's and
		Henderson	s mo	oving.	averages (w	1thout deri	vation	i). Sta	tionary and Non-
		stationary	11me	e seri	es- Autoco	Portmanto	unction	on (A	UF) and Partial
		Box–Pierce	e test	Tuncu	UII (FACF)	- rorunalite	au les	sis. LJI	ing-dox test and
		2011 10100							

UNIT V: 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).

Extended	Questions related to the above topics, from various competitive
Professional	examinations UPSC / TRB / NET / UGC - CSIR / GATE / TNPSC /
Component (is a part	others to be solved
of internal	(To be discussed during the Tutorial hour)
component only, Not	
to be included in the	
External Examination	
question paper)	
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional
this course	Competency, Professional Communication and Transferrable Skill
Recommended	1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003):
Text Books	Introduction toLinear regression analysis, third edition, John Wiley and Sons Inc.
	2 Draper NR and Smith H (2000) · Applied Regression Analysis
	2nd edition. John Wilev& Sons.
	3. Spyros Makridakis, Steven C. Wheelwright and Victor E.
	McGee (2012), ForecastingMethods and Applications – Second
	Edition, John Wiley & Sons.
	4. T.M.J.A.Cooray(2008): Applied Time Series Analysis and
	Forecasting, NAROSApublishing house Pvt.Ltd
	5. Box, G.E., Jenkins, G.M. and Reinsel, G.C. (2013) Time Series
	Analysis: Forecasting and Control. 4th Edition, John Wiley & Sons,
	Hoboken, 746 p.
Reference Books	1. Chattergee S. and Betram Price (19/7): Regression Analysis by
	Examples, John Wiley& Sons.
	2. George E.F. box and Gwiryin M. Jenkins (1970). This Series Analysis – Forecasting and Control Holdne – Day Inc.
	3 Johnston I (1984) · Econometric Methods (3rd Edition) McGraw
	Hill InternationalBook Company New Delhi
	4. Singh, Parashar and Singh (1997): Econometrics and
	Mathematical Economics (1stEdition), S. Chand & Co, New Delhi.
Website and	1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
e-Learning Source	2. http://www.opensource.org, www.mathpages.com

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-Jenkings model
- 4. Fitting time series model and evaluating goodness of fit

CO-PO Mapping (Course Articulation Matrix)

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

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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.7 Testing of Statistical Hypothesis

Title of the	Course	Testing of	Stati	stical	Hypothesis	5			
Paper Nun	nber	VII							
Category	CC	Year	II		Credits	5	Course		23PSTCT07
		Semester	III				Cod	e	
Instruction	nal Hours	Lecture		Tuto	orial	Lab Prac	tice	Tota	1
per week		5		1		_		6	
Pre-requis	ite	Under Gra	duate	Leve	l Probability	/ Theory an	d Test	ting of	Statistical
-		Hypothesi	s.		-	-		•	
Objectives	of the	1.	To ge	t theo	retical knov	vledge in St	tatistic	al Tes	ting procedure
Course		2.	To pr	ovide	knowledge	about Mos	t Powe	erful te	est and how to
			build	it.					
		3.	To ur	nderst	and Hypoth	esis testing	conce	pts.	
		4.	To de	velop	analytical t	hinking in s	statisti	cal tes	ting of
			hypot	hesis.					
Course Ou	ıtline	UNIT I: Uniformly most powerful tests, the Neyman-Pearson							
		fundamental Lemma, Distributions with monotone likelihood ratio							
		Problems.							
			Ger	neraliz	zation of	the funda	imenta	l lem	ima, two sided
		nypotneses	, testi	ng the	e mean and	variance of	a nori	mai dis	stribution.
		UNIT II	I: U	nbiase	edness for	hypothes	es te	esting,	similarity and
		completeness, UMP unbiased tests for multi parameter exponential							
		families, c	ompa	ring	two Poisso	n or Bino	mial _l	popula	tions, testing the
		parameters	of a	norma	al distribution	on (unbiase	ed tests	s), con	nparing the mean
		and variance of two normal distributions.							
		UNIT IV: Symmetry and invariance, maximal invariance, most powerful							
		invariant te	ests.						
		UNIT V:	SPRT	proce	edures, like	lihood ratio	b tests	, local	ly most powerful
		tests, the co	oncept	t of co	onfidence se	ts.			

Extended	Questions related to the above topics, from various competitive
Professional	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /
Component (is a part	others to be solved
of internal	(To be discussed during the Tutorial hour)
component only Not	
to be included in the	
External Examination	
question paper)	
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional
this course	Competency, Professional Communication and Transferrable Skill
Recommended	1. V.K.Rohatgi et a l(2002) : An introduction to probability and
Text Books	statistics, John Wiley.
	2. Lehmann, E.L. (2005) : Testing of statistical hypothesis, 3 rd Edn.,
	John Wiley.
Reference Books	1. Ferguson, T.S. (1967) : Mathematical statistics, A decision theoretic
	approach, Academic press.
	2. Rao, C.R. (1973) : Linear statistical inference and its applications,
	Wiley Eastern, 2nd ed.
	3. Gibbons, J.D. (1971) : Non-parametric statistical inference,
	McGraw Hill.
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for
e-Learning Source	thissubject.

Students will be able to

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

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

CO-PO Mapping (Course Articulation Matrix)

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.8 Linear Models

Title of the	Course	Linear Models									
Paper Nun	nber	VIII									
Category	CC	Year	Π		Credits	5	Course				
		Semester	III				Cod	e	23PSTCT08		
Instruction	nal Hours	Lecture		Tuto	orial	Lab Prace	tice	Tota	1		
per week		5		1		-		6			
Pre-requis	ite	UG level l	inear	regress	ion analysis	and Statistic	al Infe	rence			
Objectives	of the	1. To mod	lel cr	oss sec	ctional data	using minir	num r	umbe	r of parameters		
Course		2. To estin	nate	unbias	ed estimato	rs for mode	l para	meters	5		
		3. To estimate standard errors of estimates to construct the confidence									
		intervals.									
	1.	4. To test	the g	oodne	ss of fit of the	he models	D /	1 .1.			
Course Out	line	UNIT I:	Linea	ar Mo	dels – Cla	ssification,	Estir	nabilit	y. The General		
		Normal Theory) - Gauss-Markov theorem Tests of Hypothesis - Testing									
		(Normal Theory) – Gauss–Markov theorem, Tests of Hypothesis – Testing the Hypothesis $\beta = \beta^*$									
		$\frac{1}{2}$									
		UNIT - II	:Inti	oduct	ion to Gene	ralized Lin	ear M	lodels:	Components of		
		Generalize	i Lir	ear N	lodel, Bino	miai Logit ity Model 1	NIOO Internation	el, Poi	Isson Log-linear		
				thode	of Estimatic	ny model, n	ry les	et cou	ares generalized		
		least square	e ma	ximize	likelihood.	BLUE		isi syu	ares, generalized		
			<u>v. c</u>	1	<u> </u>	4	<u> </u>		1 /1		
UNIT – IV: General Linear Hypothesis – four con								comm	on nypotneses –		
		reduced models – null model – saturated model.									
		UNIT - V: Regression and dummy variables - grouped variables -									
		unbalanced data - describing linear models- 1-way classification, 2- way									
		classification	on.								

Extended	Questions related to the above topics, from various competitive
Professional	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /
Component (is a part	others to be solved
of internal	(To be discussed during the Tutorial hour)
component only. Not	
to be included in the	
External Examination	
question paper)	
question puper)	
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional
this course	Competency, Professional Communication and Transferrable Skill
Recommended	1. S.R. Searle, Linear Models, John Wiley, 1971.
Text Books	2. Das. M.N and Gri. N.C. Design and Analysis of Experiments (1979)
	New Age International Puplications.
Reference Books	1. Alan Agresti, (2002): Categorical Data Analysis, WileyInterscience,
	John Wiley& Sons
	2. Radhakrishna Rao, "Linear Statistical Inference and its
	Applications" Wiley-Interscience, 2ed 2001 ISBN:
	0471218758
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for
e-Learning Source	this subject.

Students will be able to

- 1. Understand about statistical modelling
- 2. To model the given cross sectional data
- 3. To evaluate the model
- 4. Interpret the model based on the variables involved
- 5. To predict using fitted model

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.9 Multivariate Analysis

Title of the	Course	Multivariate Analysis										
Paper Nun	nber	IX				-						
Category	CC	Year	II	Credits	5	Cou	rse					
		Semester	III			Cod	e	23PSTCT09				
Instruction	nal Hours	Lecture	Tuto	orial	Lab Pract	tice	Tota	1				
per week		5	1 - 6									
Pre-requis	ite	Univariate and Multivariate distribution theory, Linear Algebra										
Objectives	of the	1.	To impa	rt basic	theoretical	kn	owledg	ge about				
Course			multivariat	e normal d	istribution,	its p	roperti	es to deal				
			with multi	-dimension	data. To L	erive	intere	ince based				
		vector and Covariance matrix.										
		2. To provide requisite knowledge to handle multi-										
			dimensiona	ıl data v	vith regar	d to	o dime	ensionality				
			reduction	using Prin	ncipal Cor	npone	ent ar	nd Factor				
			Analysis. 7	To imbibe sl	kills to clas	sify a	nd ass	ign a new				
			item/object	to any of the	he two or n	nore p	opulat	ions using				
		_	Discrimina	tion and Cla	ssification.							
		3.	To instruct	theoretical	knowledge	to g	roup v	ariables or items				
Course Ou	tlino	LINIT I. N	that belong	to multi- di	mensional (ata u	sing C	luster algorithms				
Course Ou		Likelihood	Estimators	ofParamete	ers, Distribu	tion c	of Sam	ple Mean Vector,				
		Sample Di	spersion Ma	atrix.	,			1				
		UNIT II:	Partial and	multiple co	rrelation co	effici	ents- N	Null distribution -				
		Application	n in tests of	ig. Inull di n mean vect	or for one	or Ho and m	oremi	g s 1 statistics. Iltivariate normal				
		populations and also on equality of the components of a mean vector in a										
		multivariat	e normal po	opulation	1							
		UNIT III:	Classificat	ion and disc	rimination	proce	dures f	for discrimination				
		between t	wo multiva	ariate norm	al populati	ions	– Line	ear Discriminant				
		function,	Mahalanob	is Distance	e, tests as	sociat	ed w	ith Discriminant				
		functions,	probabilit	ies of mi	ISCIASSIFICAT nultivariate	10n norm	and t	neir estimation,				
		classificati			muntivariate	norm	ai pop	ulations.				
		UNIT IV	Principal component Analysis, Canonical variables and									
		canonical correlation, clustering- similarity measures- hierarchical										
		algorithms	- Single Lin	ikage, Non-l	hierarchical	Clust	ering					
		UNIT V. Contingency Tables Correspondence Analysis for Two										
		Dimension Contingency Table										
			0,	•								

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

Students will be able to

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

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.10Design of Experiments

Title of the	Course	Design of Experiments									
Paper Nun	nber	X									
Category	CC	Year	II		Credits	5	Cou	rse			
		Semester	III				Cod	e	23PSTCT10		
Instruction	nal Hours	Lecture		Tuto	orial	Lab Pract	tice	Tota	1		
per week		5		1		-		6			
Pre-requis	ite	Matrix algebra & Linear Models.									
Objectives	of the	1. To	get t	heore	tical know	ledge in	Statist	ical l	Design of		
Course		Expe	rimen	nts and	d analysis of	variance		0.1			
		2. To b	2. To build strong theoretical foundation in Orthogonal faith								
		squar	riol or	yper (Graeco Latil	nsquares, 1a	actror	al and	anlit plot		
		analy	analysis covariance. Posponse surface methodology								
		3 To de	evelor	n anal	vtical thinki	ng in prohl	em so	lving	y skills		
		5. 10 0		p unu	yucur unnu	ing in proof	0111 50	iving (
Course Ou	tline	UNIT I: R	eview	of ba	sic designs:	Orthogona	l latir	squar	es. Hyper Graeco		
		Latin squar	res –	analy	sis of varia	nce – mult	tiple of	compa	risons – multiple		
		range tests	- Miss	sing p	olot techniqu	le.					
		UNIT II:	Gene	eral f	actorial exp	periments,	study	of 2	and 3 factorial		
		Erectional	s in i	rando	mized bloc	ks; comple	ete an	d par	tial confounding;		
		factorials	uesig	IIS IC	n symmetri		s, Das	sic luc	ca of asymmetric		
		UNIT III:	Gener	ral blo	ock design a	nd its infor	matio	n matr	ix (C), criteria for		
		connectedn	ess, b	alanc	edand ortho	gonality; B	IBD -	- recov	very of interblock		
		information	ı; PBI	IBD(2	2) Associat	tion scheme	e, Intr	ablock	analysis, Lattice		
		Design –an	alysis	; You	Iden design	– intrablock	c anal	ysis.			
		UNIT IV:	Neste	d and	l split plot d	esigns – T	wo sta	ige nes	sted designs, split		
		covariance	is, sp with a	one t	wo covariate	signs, strij	p-spm trials	desig	gns, Analysis of		
			with	one, t	wo covariad	cs, ennieur					
		UNIT V: I rotatable de	Respo esigns	onse s and i	surface methes application	nodology - ons.	first	order	and second order		
Extended		Questions	relate	ed to	the abov	ve topics,	from	vario	ous competitive		
Professiona	ıl	examinatio	ns UF	PSC /	TRB / NE	T / UGC -	- CSI	R / G.	ATE / TNPSC /		
Component	t (is a part	others to be	e solve	ed							
of	internal	(To be disc	ussed	durir	ng the Tutori	al hour)					
component	only, Not				-						
to be includ	ded in the										
External											
Examinatio	n										
question pa	per)										
Skills acqu	ired from	Knowledge	e, Pi	robleı	n Solving	Analytic	al a	bility,	Professional		
this course	:	Competenc	y, Pro	ofessio	onal Commu	unication an	ıd Tra	nsferra	able Skill		
Recommen	nded	1.	Das, I	M.N.	and Giri, N	. (1979) : I	Design	and a	analysis of		
Text Books	8		experi	iment	s, Wiley Ea	stern.			1		
		2.	John,	P.W.	<u>M. (1971) :</u>	Statistical c	lesign	and a	nalysis of		

		experiments, Macmillan.				
Reference Books	1.	. Montgomery, C.D. (2001) : Design and analysis of				
		experiments, John Wiley, NewYork.				
	2.	Robert, O., Kuelhl(2000) : Design of experiments.				
		Statistical principles of researchdesign and analysis,				
		Duxbury.				
	3.	Federer, W.T.(1963) : Experimental design; Theory and				
		application, Oxford & IBHpublishing Co.				
	4.	Raymond H. Myers, Douglas C. Montgomery, Christine M.				
		Anderson-Cook (2016), Response Surface Methodology:				
		Process and Product Optimization Using Designed				
		Experiments, 4th Edition.				
Website and	e-books, o	online tutorials taken from MOOC/SWAYAM platform for				
e-Learning Source	thissubject	ct.				

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.

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3

CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

11.1.11Stochastic Process

Title of the Cour	rse				Stoch	astic Proce	SS				
Paper Number		XI									
Category CC		Year	II		Credits	5	Cou	rse			
		Semester	IV				Cod	e	23PSTCT11		
Instructional Ho	ours	Lecture		Tuto	rial	Lab Practice		Tota	l		
per week		5	1			- 6					
Pre-requisite		Probability	theo	ry and	Distributio	n theory					
Objectives of	the	1.	To e	xpose	the basic co	oncepts of t	he the	eory o	f		
Course			stoch	astic p	processes an	nd develops	them	athem	atical		
		2	To u	y of ra nderst:	and the appl	esses. lications of l	Stoch	astic P	rocess as		
		a Mathematical tool.									
		3. To describe the advanced topics related to									
			conti	nuous	and discre	te time rar	ndomp	process	ses.		
Course Outline		UNIT I: I	Defin	ition o	of Stochasti	ic process -	- Spe	cificat	ion of Stochastic		
		Processes.	Stat	10nary	Processes	- Second	orde	r proc conarti	ess, Stationarity,		
		discrete ti	me –	- Supe	er martinga	les and su	b ma	rtinga	les - Continuous		
		Parameter	Ma	rtigale	s- Martin	gale conv	ergen	ce th	neorem and its		
		application	IS	-		-	-				
		UNIT II:	Mar	kov c	hains – D	efinitions a	and e	xampl	es. Higher order		
		transition p	proba	bilities	: Chapman	– Kolmogr	ov eq	uation	. Classification of		
		States and Probabiliti	d C	hains	– Determ	ination of	Hig	gher (r Stal	Order Transition		
		system.	CS -A	periou		minting Den	laviou	1. Stat	Sinty of a Markov		
		~) ~ · · · · · ·									
		UNIT III:	Pois	sson p	rocess – Po	oisson proc	ess ai	nd rela	ated distributions.		
		Pure Birth	1 Pro	cess -	– Birth an	d Death p	proces	s - s	Simple examples.		
		process –	Prob	ability	of extinction	on – fundai	aung menta	1 theo	rem of branching		
		process.	11000	aonney	or extineu	in rundu	menta	i theo	form of brunening		
		UNIT IV:	Rene	ewal tl	neory - Ren	newal equat	ion -	Stoppi	ing time - Wald's		
		equation - Elementary renewal theorem and its applications - Renewa							ations - Renewal		
		reward pro	ocesse	es - Ke	sidual and	Excess life	times	s - Ma	rkov renewal and		
			ov pi	000330							
		UNIT V:	Queu	ing m	odel $\overline{M/M/1}$: Steady St	ate B	ehavio	our - Steady State		
		Solution,	Waiti	ng tin Naitin	ne distribut	ion. Queue	ing N	/lodel	M/M/S - Steady		
		State Solut	ion, v	w altin	g une distri	ioutions – si	imple	proble	лп.		

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)								
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional								
this course	Competency, Professional Communication and Transferrable Skill								
Recommended Text Books	 Medhi, J. (2017): Stochastic Processes, New Age International Publishing Limited, New Delhi. (Reprint 2002). Karlin, S. and Taylor H.M. (1996): First Course in Stochastic Process, Academic Press. Cox. D.R and Muller (1984) The Theory of Stochastic Process Chapman & Hall/crc, Boca Raton London New York. 								
Reference Books	 Prabhu. N.U. (1965) : Stochastic Process, Macmillan, New York. Ross, S.M (1996): Stochastic Processes, 2nd Edition, John Wiley & Sons, New Delhi. 								
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.								

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.

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

CO-PO Mapping (Course Articulation Matrix)

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.1.12Machine Learning Techniques

Title of the	e Course	Machine Learning Techniques								
Paper Nun	nber	XII			-					
Category	CC	Year	II	Credits	4	Cou	rse			
		Semester	IV			Cod	Code 23PSTCT12			
Instruction	nal Hours	Lecture	Tuto	orial	Lab Pract	tice	Tota	ıl		
per week		5	5 1 - 6							
Pre-requis	ite	UG level l	Programmi	ng skill, Reg	gression ana	lysis				
Objectives Course	of the	1. 2. 3.	 Acquire theoretical knowledge on setting hypothesis for pattern recognition. Apply suitable machine learning techniques for data handling and to gain knowledgefrom it. Evaluate the performance of algorithms and to provide solution for various real-worldapplications. 							
Course Ou	ıtline	UNIT I: Data types – Measures of similarity and dissimilarity – Hierarchical Clustering Methods – k-means and k-medoids clustering methods – Clustering Validity measures.								
		UNIT II: Decision T Splitting o Neighbor o	Fuzzy c- Frees – But f nodes ba classifiers –	means – I ilding a dec sed on info kNN algori	Fuzzy Clus cision tree - ormation ga thm – Naïve	tering - Tree in and e Baye	Vali e indu d Gin esian	idity Measures – action algorithm – i index - Nearest classifier.		
		UNIT III: 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.								
		UNIT IV: 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.								
		UNIT V: Error-Corr Adaboost, Bayes Clas	Ensemble ecting Outp Stacking. 1 ssifier, Baye	Learning out Codes, E Bayesian Le esian Belief	Model Cor Bagging: Ra earning, Bay Networks, I	mbina ndom yes Op Mining	tion Fores otimal g Frec	Schemes, Voting, st Trees, Boosting: Classifier, Naïve quent Patterns.		

Extended	Questions related to the above topics, from various competitive
Professional	examinations UPSC / TRB / NET / UGC - CSIR / GATE / TNPSC /
Component (is a part	others to be solved
of internal	(To be discussed during the Tutorial hour)
component only, Not	
to be included in the	
External	
Examination	
question paper)	
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional
this course	Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Tan, T., Steinbach, M. and Kumar, V. (2006):
Books	 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. Han, J. and Kamber, M. (2006): Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publishers.
Reference Books	 Paolo Gludici (2003): Applied Data Mining: Statistical Methods for Business and Industry, John Wiley and sons. Rajan Chattamvelli (2009): Data Mining Methods, Narosa Publishing House, New Delhi. Wayne,W.David(1987) : A foundation for analysis in Health Sciences 4th ed., John Wiley & Sons. Jerrold H.Zar (1984) : Bio statistical analysis, Prentice hall 2nd ed. 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.
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for
e-Learning Source	thissubject.

Students will be able to

- 1. Recognize the characteristics of machine learning strategies.
- 2. Apply various supervised learning methods to appropriate problems.
- 3. Identify and integrate more than one technique to enhance the performance of learning.
- 4. Create probabilistic and unsupervised learning models for handling unknown pattern
- 5. 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	М	Μ	Μ	S	М	S	Μ	М
CO2	S	S	S	S	М	S	М	S	М	М
CO3	S	S	S	М	S	S	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	3.0

11.2 Elective Courses

Semester I: Elective I and Elective II

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

11.2.1 Group A:

Categorical Data Analysis

Title of the Course	Categorical Data Analysis								
Paper Number	Ι						-		
Category ED	Year	Ι	Credits	3	Cour	rse			
	Semeste	Ι			Code	e	23PSTME01		
	r								
Instructional Hours	Lecture	1	Tutorial	Lab		Total			
per week	2	1		Practice	e	4			
	3		. 10	-	,	4			
Pre-requisite	Undergra	duate	Level Statist	ical Mode	els.				
Objectives of the	1. Th	e aim	of this cours	e is to der	nonstr	rate s	tudents both theoretical		
Course	rat	ionale	and importa	nt applica	ations of	of ca	tegorical data analysis		
	me	thods.							
	2. Pro	ovide s	students with	skills to	either	cond	luct their own research		
	US1	ng cat	egorical data	analysis	or to t	be ab	le to replicate existing		
	res	earch	using these i	nethous.					
	TINITT T.	M. 1	-1. f D'			7	les Les L'acco Medale		
Course Outline	Fitting Log linear and Logic Models-Building and applying Log Linear								
	Models,	Log- L	inear- Logit	Models f	or Ord	dinal	Variables.		
	UNIT II	: Mul	tinomial Re	sponse M	Iodels	- M	odels for Matched Pairs-		
	Analyzin	g Rep	eated Catego	rical Res	ponse	Data	a - Asymptotic Theory for		
	Parametr	ic Mo	dels - Estima	tion Theo	bry for	Para	ametric Models.		
	UNIT II	I: Intr	oduction to	continger	ncy tal	bles:	2×2 and $r \times c$ tables –		
	measures	of	association	and no	onpara	imetr	ic methods. Tests for		
	independ	ence a	ind homogen	etty of pr	coporti	lons	- Fishers exact test - Odds		
	tables -1	full ind	lependence :	and condi	tional	inde	pendence - collapsing and		
	Simpson	s parac	lox.		tionai	mue	pendence conapsing and		
	UNIT IV	/: Ger	neralized line	ear mode	ls - L	ogist	ic regression for binary -		
	multinomial and ordinal data - Log-linear models - Poisson regress								
	Modeling	g repea	ited measure	ments - g	eneral	ized	estimating equations.		
	UNIT V	Poly	chromous lo	git model	s for c	ordin	al and nominal response -		
	Log-linea	ar mo	dels (and	graphical	mod	lels)	for multi-way tables -		
	Causality	, repe	ated measur	es, genera	alized	least	t squares - mixed models,		
	latent-cla	ss mo	dels, missing	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)
Skills acquired from this course Recommended Text Books	 Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill 1. Agresti, Alan. (1996) An Introduction to Categorical Data Analysis, Wiley, New York.
Reference Books	 Bergsma, W. Croon, M.A. and Hagenaars, J.A. (2009) Marginal Models: For Dependent, Clustered, and Longitudinal Categorical Data. Springer, New York. Bishop, Y.M. Fienberg, S.E. and Holland, P.W. (1975) Discrete Multivariate Analysis: Theory and Practice, MIT Press, Cambridge. Edwards, D. (2000). Introduction to Graphical Modeling, 2/e, Springer, New York. Fienberg, S.E. (1980). The Analysis of Cross-Classified Categorical Data. MIT Press, Cambridge. Wasserman, L. (2004) All of Statistics: A Concise Course in Statistical Inference. Springer, New York.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Students will be able to

- 1. The student who successfully completes this course should have a reasonable grasp of the theoretical foundations of categorical data analysis and have sufficient skills to apply categorical data analysis methods.
- 2. The student will be able to derive and work with sampling distributions of binary or categorical measures.
- 3. Students will be familiar with a variety of methods for analyzing categorical or count data.

CO-PO Mapping (Course Articulation Matrix)

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	S	S	М	Μ	Μ	S	М	S	Μ	М
CO2	S	S	S	S	М	S	М	S	М	М
CO3	S	S	S	М	S	S	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	3.0	5.0	5.0	3.0

Population Studies									
Title of the	Course			Рор	ulation Stu	ıdies			
Paper Num	ber	Π							
Category	ED	Year I		Credits	3	Cou	rse		
		Semeste I				Cod	e	23PSTME02	
		r					1		
Instruction	al Hours	Lecture	Tut	orial	Lab Prac	tice	Tota	.1	
per week		3 1 - 4							
Pre-requisi	te	Undergradu	ate lev	vel Demogra	phy.				
Objectives	of	1	This c	course aims t	o provide s	tudent	ts with	basic	
the Course		k	nowle	dge of statist	ical techniq	ues w	hich ca	an be used in	
		d	emogr	aphic analys	is.				
		2	The c	ourse will als	so help in s	tudyin	ig Popi	ulation growth	
		a	nd pop	oulation proje	ection.				
				1' D (·	1 /		D' (1	
Course Out	line	Deaths Mi	mogra	Marriages	inants of Po	pulati	Ion Cha Natur	ange–Births,	
		Population a	nd Gr	owth of Pop	ulation-Me	asurei	nent a	nd Indicators of	
		Demographi	c Dete	erminants: Fe	rtility, Mor	tality,	Migra	tion, Marriage.	
		UNIT II: Da	ata Soi	urces-Censu	s–Vital Reg	gistrati	ion Sys	stem–National	
		Sample Surveys–Sample Registration System–Adhoc Surveys–							
		Standard Fertility Survey–National Family Health Survey.							
		UNIT III: Population Theories—History and Development of Population Theories—Mercantilist and Related Theories Theories of							
		Propulation Theories–Mercantilist and Related Theories - Theories of Malthus and his Immediate Predecessors – Socialist and Marvist							
		Withings-Growth Theories							
		UNIT IV: Concepts of Fertility and Fecundity-theory of Marriage							
		and Family-	Social	Structure an	d Fertility-	Role of	of Inter	rmediate	
		Variables (Davis and Blake). Concept of mortality and its measures.							
		UNIT V: Indian Population Policy-Kinds of Population Policy,							
		Fertility Infl	uencin	g Policy, An	ti-National	Polic	у, Рорі	ulation	
Extanded D	ofaccional	Education.	alatad	to the obe	va torias	from		us somestitive	
Extended Pl	Generated f	Questions h		C / TDD / N	The topics,			as competitive	
Component	(is a part of	examination	s UPS	C / IKB / N	EI/UGC·	- CSI	K / GF	ATE / INPSC /	
internal	auly Not to	others to be solved							
	inity, Not to	(To be discussed during the Tutorial hour)							
be included	in the								
External Ex	amination								
question par	irod from	Knowledge	Dro	hlam Solvi	ng Analy	rtical	abilit	±x7	
Skiis acqu		Knowledge, Problem Solving, Analytical ability, Professional							
uns course		Competency Professional Communication and Transformula Shill							
Recommen	ded	1. Kuma	r, R. (1986): Techn	ical Demos	graphy	, Wile	ey	
Text		Easter	n Ltd.	,		- r -,			
		2. Benia	nin. R	. (1969): Dei	mographic	Analv	sis. Ge	eorge, Allen and	
		Unwin	1.	(0-) . 20	0 P 0	y	, 		

Reference Books	 Cox, P.R. (1970): Demography, Cambridge University Press. Keyfitz, N. (1977): Introduction to the Mathematics of Population-with Revisions, Addison-Wesley, London. Spiegelman, M. (1969): Introduction to Demographic Analysis, Harvard University Press. Wolfenden, H.H. (1954): Population Statistics and Their Compilation, Am Actuarial Society.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

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

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

CO-PO Mapping (Course Articulation Matrix)

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.2.2 Group B: Bayesian Inference

Title of the Course	Bayesian Inference									
Paper Number	III			-						
Category ED	Year	Ι		Credits	3	Course Code				
	Semester	Ι						23PSTME03		
Instructional Hours	Lecture		Tut	orial	Lab Pra	ctice Tota		al		
per week	3 1			-		4				
Pre-requisite	Probability	Probability models, parametric and non-parametric inference.								
Objectives of the	1. E	Estim	ation	using pre-k	nowledge	about	the pa	arameters.		
Course	2. To learn and develop scientific view to study the statistical challenges of clinical comparison of two or more treatment									
Course Outline	UNIT1: St	tatist	ical d	lecision the	$\frac{1}{\text{orv} - \log s}$	funct	ions -	– 0-1. absolute		
	error, squa	red	error	and LINE	X loss fu	nction	is – r	isk function –		
	minimax so	olutio	on – p	orior distribu	ution – Bay	ves ris	k – Ba	ayes solution to		
	decision pr	oblei	ms.							
	UNIT II:	Subie	ective	probability	v – its inte	rpreta	tion a	nd evaluation -		
	Subjective	deter	rmina	tion of prio	r distributi	ons -	Impro	oper prior, non-		
	informative prior, invariant prior, Jeffrey's non informative prior and									
	natural conjugate prior – family of distributions admitting natural									
	Conjugate prior.									
	functions – generalization to convex loss functions - Evaluation of									
	the estimate in terms of posterior risk – comparison with frequentist									
	methods.									
	UNIT IV: Interval estimation – credible interval, highest posterior									
	density region - Comparison of interpretation of the confidence co-									
	efficient of an interval by Bayesian and frequentist methods – simple									
	proteins.									
	UNIT V: Bayesian testing of statistical hypotheses – specification of									
	the appropriate form of the prior distribution for Bayesian hypothesis									
	α results problem – prior odds, posterior odds, Bayes factor and their computations to various hypotheses testing problems – specification									
	of Bayes te	sts.	, van	ous nypoin		5 proc	nemis	specification		
Extended Professional	Questions related to the above topics, from various competitive									
Component (is a partof	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /									
internal	others to be solved									
component only, Notto be	(To be discussed during the Tutorial hour)									
included in theExternal										
Examination										
question paper)										
Skills acquired from	Knowledg	e, I	Proble	em Solvin	g, Analy	tical	abilit	y,		
this course	Commenter	I av P	Profes	ssional	minication		[more of	amable St-11		

Recommended Text Books	 Bansal, A.K. (2007) Bayesian Parametric Inference, Narosa, New Delhi. Berger, J.O. (1985) Statistical Decision Theory and Bayesian Analysis,2/e, Springer, New York.
Reference Books	 Bernardo, J.M. and Smith, A.F.M. (2000) Bayesian Theory, Wiley, New York. Gelman, A. Carlin, J.B. Stern, H.B. and Rubin, D.B. (2013) Bayesian Data Analysis,3/e, CRC press, London Ghosh, J.K. Delampady, M. and Samanta, T. (2010) An Introduction to Bayesian Analysis: Theory and Methods, Springer, New York. Lee, P.M. (2012) Bayesian Statistics – An Introduction,4/e,Wiley, London. Leonard, T. and J.S.J. Hsu. (1999) Bayesian Methods: An Analysis for Statisticians and Interdisciplinary Researchers, Cambridge University Press, London.
Website and	e-books, online tutorials taken from MOOC/SWAYAM
e-Learning Source	platform for thissubject.

Students will be able to

- 1. Explain in detail the Bayesian framework for data analysis and its flexibility and be able to demonstrate when the Bayesian approach can be beneficial.
- 2. Develop, analytically describe, and implement both single and multi- parameter probability models in the Bayesian framework.
- 3. Demonstrate the role of the prior distribution in Bayesian inference and be able to articulate the usage of non-informative priors and conjugate priors.
- 4. Show high level Interpretation of Bayesian Analysis Results and be able to readily perform Bayesian model evaluation and assessment

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

CO-PO Mapping (Course Articulation Matrix)

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0


Title of the	Course	Statistical Quality Control								
Paper Num	ber	IV								
Category	ED	Year	Ι		Credits	3	Cou	rse		
		Semester	Ι				Cod	e	23PSTME04	
Instruction	al Hours	Lecture		Tut	orial	Lab Prac	tice	Tota	1	
per week		3		1			4			
Pre-requisit	te	Basics in Pr	Basics in Probability distributions, sampling, testing of hypotheses.							
		control char	rts an	d insp	pection samp	oling plans.			_	
Objectives	of the	The main of	bjecti	ves o	f this course	are to:				
Course		 Understand the application of statistics in industrial environment. Acquire knowhow on manufacturing process changes and process variability. Attain proficiency in process capability analysis, Instruct theory and practice of product control methodology. Comprehend the importance of reliability theory in industries. 								
Course Out	line	Unit I Statistical process control: Moving average control chart – EWMA Control chart. Basic principles and design of CUSUM control chart – two sided and one-sided procedures – V-mask technique, Tabular CUSUM and decision interval.								
		Unit II: Ac attributes – its uses – O and consum Unit III: S	cepta singl C, A lers ri Samp	ance s e, do SN, A isk an ling i	sampling – 1 uble and mu ATI and AO ad OC curve. inspection b	ot formation ltiple samp Q forms, A	n - sa pling p OQ, I - me	amplin blans – LTPD, erits a	g inspection by operations and procedures risk nd demerits of	
		Unit IV: (modification	Conti ns –	nuou	C curve and s sampling ept of AOQ	the parame plan by a L in CSP	eters of $\frac{1}{3}$	tes – ulti le	CSP-I and its	
		Solomon - function.	sequ	– op lentia	l sampling	plans by	attribu	P of I ites –	OC and ASN	
		Unit V: Qu Quality – Q Quality Aud – Implemen	uality Qualit dit – 1 Itation	Polio y Pol Need n.	cy and Obje icy Deployn for ISO 900	ctive – Pla nent – Qua 0 Systems	anning Ility F – Cla	and cunction unction uses –	organization for n deployment – Documentation	
Extended Pro	fessional	Questions	relate	ed to	the above	topics, f	from	variou	s competitive	
Component (is a partof	examination	ns UF	PSC /	TRB / NET	r / UGC –	CSIR	/ GA	TE / TNPSC /	
interna	al 1 N 44	others to be	solve	ed						
component of	nly, Notto	(To be discussed during the Tutorial hour)								
External Exa	mination									
question nane	er)									
Skills acou	ired from	Knowledge	Pro	blem	Solvi	ng. A	nalvti	cal ab	ility.	
this course		Professional Skill	Com	peten	cy, Professio	onal Comm	iunica	tion an	d Transferrable	

Recommended	1. Montgomery, D.C. (2009). Introduction to Statistical Quality
Text Books	Control, Sixth Edition, Wiley India, New Delhi.
	2. John T. Burr, (2004) Elementary Statistical Quality Control
	(Second Edition), Marcel Dekker New York.
	3. Duncan, A.J. (2003). Quality Control and Industrial Statistics,
	Irwin - Illinois.
Reference Books	1. Grant, E.L., and Leavenworth, R.S. (2000). Statistical Quality
	Control, Seventh Edition, Tata McGraw Hill, New Delhi.
	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.
	3. Mahajan, M. (2002). Statistical Quality Control, (Third Edition),
	Dhanpat Rai and Co., Delhi.
	4. Schilling, E. G., and Nuebauer, D.V. (2009). Acceptance
	Sampling in Quality Control Second Edition, CRC Press, New
	York.
	5. Wetherill, G.B. (1977). Sampling Inspection and Quality Control,
	Second Edition, Chapman and Hall, London.
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform
e-Learning Source	for thissubject.

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

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

CO-PO Mapping (Course Articulation Matrix)

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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0



Title of the Course	Clinical Trials											
Paper Number	V											
Category ED	Year	Ι	Credits	3	Cou	irse						
	Seme	Ι			Cod	le	23PSTME04					
	ster											
Instructional Hours	Lectu	re T	utorial	Lab Pra	actice	Tot	al					
per week	3	1		-		4						
Pre-requisite	Under	gradua	e Level Stat	istical Mo	dels.							
Objectives of the	1.	The co	urse stresses	on the co	oncept	ts of s	statistical design and					
Course		analysi	s in biomedi	cal reseau	ch, w	ith sp	pecial emphasis on clinical					
		trials.										
	2.	To lear	n and develo	op scienti	fic vie	ew to	study the statistical					
		challenges of clinical comparison of two or more treatment										
Course Outline	UNIT	1: Intr	oduction to	clinical ti	ials: 1	need :	and ethics of clinical trials,					
	bias a	nd ran	dom error	in clinica	al stud	dies,	conduct of clinical trials,					
	overvi dofinit	ew or I	nase I-IV ti	nais, mui	abaga	er tria	als. Data management: data					
	for g	ood c	inical prac	orns, uau	avase	abilit	y pharmacokinetics and					
	pharm	pharmacodynamics two-compartment model										
	UNIT	II: De	sign of clini	cal trials:	paral	lel vs	. cross-over designs, cross-					
	section	nal vs.	longitudinal	l designs,	obje	ctives	s and endpoints of clinical					
	trials,	design	of Phase I	trials, de	esign	of si	ngle stage and multi-stage					
	Phase	II trials	•									
	UNIT	III: I	esign and	monitorin	g of	Phase	e III trials with sequential					
	stoppi	ng, des	ign of bio-e	equivalen	ce tria	als. Ir	iference for 2x2 crossover					
	design	: Cla	ssical met	hods of	inte	erval	hypothesis testing for					
	UNIT		wor and sa	methous,	, nonp dotor	minat	tion multiplicative (or log					
	transfo	ormed)	model ML	method a	of esti	matic	on assessment of inter and					
	intra	subject	variabilitie	es. detec	tion	of o	utlying subjects. Optimal					
	crosso	ver des	igns: Balaai	ns design	, Two	o-sequ	uence dual design. Optimal					
	four p	eriod d	esigns. Ass	essment of	of bic	equiv	valence for more than two					
	drugs,	Willia	ns design.									
	UNIT	V: De	signs based	on clinic	cal en	dpoin	ts: Weighted least squares					
	metho	d, log	linear mod	els, gene	eralize	ed es	stimating equations. Drug					
	interac	ction s	udy, dose	proportio	onality	/ stu	dy, steady state analysis.					
	Anoly	n analy	sis and gro	up seque	ntial	tests,	alpha spending functions.					
Extended Drafessies -1	Owast	515 UI C	lotod to the	na.	ton		nom vorious compatitions					
Extended Professional	Questi	ons re	ialed to th	e above	lopi	us, II	COMP / CATE / TRUESCO					
Component (is a partor	exami	nations	UPSC / TR	CB / NET	/ UC	iC –	CSIR / GATE / TNPSC /					
internal	others	to be s	blved									
component only, Notto	(To be	discus	sed during the	he Tutoria	al hou	r)						
be included in the												
External Examination												
question paper)												

Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional									
this course	Competency, Professional Communication and Transferrable Skill									
Recommended	1. Agresti, Alan. (1996) An Introduction to Categorical Data									
Text Books	Analysis, Wiley, New York.									
	2. Marubeni .E. and Valsecchi M. G. (1994). Analyzing Survival									
	Data from Clinical Trials and Observational Studies, Wiley.									
Reference Books	1. Chow S.C. and Liu J.P.(2009). Design and Analysis of									
	Bioavailability and bioequivalence. 3rd Edn. CRC Press.									
	2. Chow S.C. and Liu J.P. (2004). Design and Analysis of									
	Clinical Trials. 2nd Edn Marcel Dekkar.									
	3. Fleiss J. L.(1989). The Design and Analysis of Clinical									
	Experiments. Wiley.									
	4. Friedman L. M. Furburg C. Demets D. L.(1998).									
	Fundamentals of Clinical Trials, Springer.									
	5. Jennison .C. and Turnbull B. W. (1999). Group Sequential									
	Methods with Applications to Clinical Trails, CRC Press.									
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform									
e-Learning Source	for thissubject.									
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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.

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15

Weighted percentage of Course	3.0	2.0	3.0	2.0	2.0
Contribution to Pos	5.0	5.0	3.0	5.0	5.0

Semester II : Elective III & Elective IV

Elective III to be chosen from Group C and Elective IV to be chosen from Group D

11.2.4 Group C:											
Actuarial	Statistics			A							
Title of the Course	X 7 X			Actua	arial Statis	tics					
Paper Number		т			2	0		1			
Category ED	Year	1		Credits	3			22DSTMEAC			
	Semester	Semester II Code 23F31				23F 5 I WIEUU					
Instructional Hours	Lecture		Tuto	orial	Lab Prac	tice	ice Total				
per week	3 1 - 4										
Pre-requisite	Basic Ski	lls ii	n Mat	hematical C	Computation	1					
Objectives of the	The main	obje	ectives	s of this cou	rse are to:						
Course	1. Knov	v the	e signi	ficance of I	mathematic	s in fi	nanci	al management.			
	2. Incul	cate	know	ledge in co	mputation of	of me	asures	s such as interest,			
	disco	discount, inflation, etc.									
	3. Unde	ersta	nd the	e notions of	Actuarial s	<u>tatisti</u>	cs.				
Course Outline	UNIT I: Measures of Mortality:- Life tables and its relation with										
	survival f	unct	$\frac{100}{100}$ -	ine table i	function at tality Gor	non nnert	intege	r age (fractional Makeham's laws			
	of mortali	tv –	Selec	t ultimate a	and agorega	ite mo	z anu ortality	v tables			
	UNIT II:	Abr	ridged	l life tables	– construct	tion o	f abri	dged life tables –			
	methods	by F	Read	and Merrel	ll, Greville	's, K	ings a	and JIA method.			
	Utility Th	eory	v – Ins	urance and	Utility The	ory.	-				
	UNIT III	: Mo	odels	for individu	al claims a	nd the	eir sur	ns – multiple life			
	function –	- joir	nt life	status and l	ast survival	statu	lS.				
	UNIT IV	7: F	Policy	Values: 1	Nature of	reser	ve -	prospective and			
	retrospect	ive 1	reserv	es - fraction	nal premiur	ns an	d frac	tional durations -			
	modified	rese	rves -	Continuou	is reserves	- Sur	render	values and paid			
	up policie	es -	Indus	trial assura	nce - Child	dren's	defei	rred assurances -			
	Joint life a	ind I	ast su	Funder Co	anital sums	on	ratira	ment and death			
	widow's	nens	sions	- Sicknes	apital sums s benefits	- R	enefit	s dependent on			
	marriage.	pen	sions	Dieknes	s benefits	D	enem	s dependent on			
Reference Books	1. Boy	vers	, N. L	. (1997). A	ctuarial Ma	them	atics,	Society of			
	Act	uario	es, Se	cond Editio	on.		,	2			
	2. Hos	sacl	к,I.B.	Pollard, J.H	I. and Zehr	wirth	, B.(1	999)Introductorv			
	stat	istic	s wit	h applicati	ons in ger	neral	insura	ance, Cambridge			
	Uni	vers	ity Pr	ess, Cambr	idge.			C			
	3. <u>Pro</u>	misl	<u>ow</u> , S	S. D. (2011). Fundame	entals	of A	ctuarial			
	Mat	them	natics,	John Wile	ey and Son	s, Nev	w Yor	k.			

- 1. To understand how actuarial science is used in finance, investments, banking and insurance.
- 2. Explain the concept of survival models
- 3. Describe estimation procedures for lifetime distributions.
- 4. To understand the statistical behavior of actuarial indicators.
- 5. To solve the problems related to the benefit amounts in insurance, annuities, premiums and reserves.

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0



Title of the Course				Simula	tion Analy	sis			
Paper Number	VII			-	-	-			
Category ED	Year	Ι		Credits	3	Cou	rse		
	Semester	II				Cod	e	23PSTME07	
Instructional Hours	Lecture		Tuto	orial	Lab Pract	tice	Total		
per week	3		1		-		4		
Pre-requisite	Basic Skill	ls in	Mathe	ematical Co	mputation				
Objectives of the	The main o	bjec	tives of	of this cours	e are to:				
Course	1. Defin	ne th	ie basi	cs of simula	ation model	ing an	d repli	cating the	
	pract	ical	situati	ions in orga	nizations		too vo	ing different	
	2. Gene			om numbers	and random	li varia	ates us	ing different	
	3 Deve	nqua elon	es. simul:	ation model	using heuri	stic m	ethode	2	
	4. Anal	vsis	of Sin	nulation mo	dels using i	nput a	nalvze	er. and output	
	analy	/zer.				r	·j	, F	
	5. Expl	ain '	Verific	ation and V	alidation of	f simu	lation	model.	
Course Outline	UNI I:	Int	roduct	ion to S	Simulation:	Sin	nulatio	on, Advantages,	
	Disadvanta	ges,	Areas	of applicat	ion, System	envir	onmer	nt, components of	
	a system, N	10de	el of a	system, typ	es of model	s, ster	os in a	simulation study.	
	Inventory S	EX. Svste	ample m Ot	s. Simulati	ion example	ung s	system	s, simulation of	
	UNITII:	Gen	eral P	rinciples: (Concepts in	discr	ete -	event simulation,	
	event sche	eduli	ng/ T	Time ¹ advan	ice algorith	nm, s	imulat	ion using event	
	scheduling.	Ra	ndom	Numbers:	Properties,	Gene	ration	s methods, Tests	
	for Randon	n nu	mber-	Frequency	test, Runs te	est, Ai	utocori	relation test.	
	UNII III: Exponentia	Kai	naom Unifo	variate Ge	ull Triand	iverse milar	distr	ibutions Direct	
	transformat	tion	for N	Jormal and	log norma	al Dis	stributi	ons. convolution	
	methods-	Erl	ang	distribution	, Accepta	ince	Rejec	tion Technique	
	Optimizatio	on V	Via Si	mulation:	Meaning, d	ifficu	lty, R	obust Heuristics,	
	Random Se	earch	1.						
	UNIT IV:	Ana	lysis c	of Simulatio	n Data Inpu	it Mo	delling	: Data collection,	
	Identification	on a	nd dis	tribution wi	ith data, par	amete	er estir	nation, Goodness	
	of fit tests,	Sele	ection	of input mo	dels withou	it data	a, Mult	tivariate and time	
	Series analy	ysis.	Ver11 alibrat	ication and Val	Validation	01 M Jodels	odel –	Model Building,	
	UNIT V: () $u_{\rm tr}$	ut Ana	ilvsis – Tvn	es of Simul	ations	». with I	Respect to Output	
	Analysis, S	toch	astic]	Nature of or	utput data, I	Measu	res of	Performance and	
	their estim	natio	n, Ou	tput analy	sis of terr	ninati	ng sir	nulation, Output	
	analysis of	stea	idy sta	te simulati	ons. Simula	tion S	Softwa	re's: Selection of	
	Simulation	Sc	oftwar	e, Simulat	ion packa	ges,	Trend	in Simulation	
	sonware.								

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination guestion 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)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency Professional Communication and Transferrable Skill
Recommended Text Books	 Barcley G.W. (1970) Techniques of Population Analysis, Wiley, New York. Borowiak, D.S. and Shapiro, A.F. (2013) Financial and Actuarial Statistics: An Introduction, CRC Press, London. Shailaja R Deshmukh (2009) "Actuarial Statistics", University Drass (India) Private Limited, Hudershed
Reference Books	1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, Discrete Event system Simulation, Pearson Education, Asia, 4th Edition, 2007, ISBN: 81-203- 2832-9.
	 Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004, ISBN : 0-87692- 028-8.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

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

- 1. Describe the role of important elements of discrete event simulation and modeling paradigm.
- 2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
- 3. Develop skills to apply simulation software to construct and execute goal-driven system models.
- 4. Interpret the model and apply the results to resolve critical issues in a real world environment.

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

Statistic	Statistical methods for Epidemiology								
Title of the Course			Statistical	methods fo	or Ep	idemi	ology		
Paper Number	VIII								
CategoryED	Year	Ι	Credits	3	Cou	rse			
	Semeste	II			Cod	le	23PSTME08		
	r								
Instructional Hours	Lecture	Tut	orial	Lab Prac	tice	Tota	1		
per week	3	1		-		4			
Pre-requisite	Undergra	aduate le	vel Demog	raphy					
Objectives of the	The main	objectiv	es of this c	ourse are to):				
Course	1. Expl	ain the r	ole of epide	emiology ii	n the	field c	of public health.		
	2. Desc	cribe and	calculate e	pidemiolo	gical	measu	res used to define and		
	quar	tify heal	th problem	s in and ac	ross c	lefine	d populations.		
	3. Desc	ribe the	range of er	oidemiolog	ic stu	dv des	signs used to examine		
	the h	ealth sta	tus of a po	pulation an	d be a	able to	evaluate the strengths		
	and	limitatio	ns of each.						
	4. Und	erstand a	nd apply e	pidemiolog	gical c	riteria	needed to establish		
	5 7 11	nderstan	d and annly	v kov othice	al icen	les to i	the conduct of		
	epid	emiologi	cal and oth	er scientifi	c inve	estigat	ions.		
Course Outline	UNIT I:	Measu	ures of dis	sease frequ	iency	: Moi	rtality/Morbidity rates-		
	incidence	rates pr	evalence ra	ites - Sourc	e of i	nortal	ity morbidity statistics-		
	hospital	records	- vital st	atistics rec	cords-	Mea	sures of accuracy or		
	validity:	sensitivit	y index - s	pecificity in	ndex-	Meas	ure of Reliability.		
	UNIT II	Epider	niologic co	oncepts of o	diseas	ses: Fa	actors which determine		
	the occu	rrence c	of diseases	- models	s of	transr	nission of infection -		
	incubatio	n period	– disease s	pectrum an	nd her	d imn	nunity.		
	UNIT II	I: Obse	rvational s	tudies in E	Epider	niolog	gy: Retrospective (case		
	control)	and pros	pective (co	ohort or lo	ngitu	dinal)	studies - Measures of		
	associatio	on: Rela	tive risk,	odds rat	io, a	ıttribu	table risk- Statistical		
	technique	s used	in analysi	s: Cornfie	ld an	id Ga	rts method - Mantel-		
	Haenszel	inethod-	· Condition	and unc	ressi	ional	matching - Analysis of		
		· Exper	imental En	idemiology	v Cli	nical 4	& commUNITy trials		
	Statistica	l Techni	aues: Met	hods for	comn	arison	\sim of two treatments -		
	Crossove	r design	with Gart	s and McN	Vemai	rs test	- Randomization in a		
	clinical tr	ial – sec	quential me	ethods in c	linica	l trial	s - clinical life tables -		
	assessme	nt of surv	vivability i	n clinical tr	ials.				
	UNIT $\overline{\mathbf{V}}$: Mathe	ematical $\overline{\mathbf{M}}$	lodeling in	Epic	lemiol	ogy:(deterministic and		
	stochastic	c) simple	epidemic	model - ge	eneral	lized e	epidemic model- Reed-		
	Frost and	Green-v	vood mode	els - model	s tor	carrie	r borne and host vector		
	diseases	- Estima	ation of la	itent and 1	intect	10US]	periods - geographical		
	spread of	the disea	ase - simula	ation of an	epide	mic.			

Extended	Questions related to the above topics, from various competitive									
Professional	examinations UPSC / TRB / NET / UGC - CSIR / GATE / TNPSC /									
Component (is a part	applied survey techniques adopted in Economics and Statistics									
of internal	department of Tamil Nadu State Government.									
component only, Not										
to be included in the	(To be discussed during the Tutorial hour)									
External										
Examination										
question paper)										
Skills acquired from	Knowledge, Problem Solving, Analytical ability,									
this course	Professional									
	Competency, Professional Communication and Transferrable Skill									
Recommended	1. Roger D. Peng Francesca Dominici, (2008), Statistical Methods for									
Text Books	Environmental Epidemiology with R, Springer.									
	2. David G. Kleinbaum, Mitchel Klein (2002). Logistic regression- A									
	selflearning approach- Springer.									
Reference Books	1. Armitage. (1980). Sequential medical trials, Charles C.									
	I homas 2 Deiles NTL (1987) The Disputies of Melaric									
	2. Balley, N.I.J. (1987). The Biomathematics of Malaria.									
	2 Elaise II (1081): Statistical Matheda for Pates and									
	Proportions John Wiley& Sons Incorporated New York									
	4 Franeuthal (1980) Mathematical Modernization in									
	Enidemiology Springer Verlag									
	5. Gross and Clark. (1989). Survival Distributions- Reliability									
	Application in Biomedical Sciences, University Microfilms.									
	6. Kahn, H.A. and C.T. Sempos. (2007). Statistical Methods in									
	Epidemiology (Second Edition). Oxford University press,									
	N.Y.									
	7. Kahn, H.A. (1983): An introduction to Epidemiologic methods.									
	Oxford University press, N.Y. (Digitized 2007).									
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for this									
e-Learning Source	subject.									

- 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.

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

CO-PO Mapping (Course Articulation Matrix)

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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	3.0	5.0	5.0	3.0

11.2.5 Group D:

Survival Analysis

Title of the Course	
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Paper Number	IX								
Category ED	Year	Ι		Credits	3	Cou	rse		
	Semester	II				Cod	e	23PSTME09	
Instructional Hours	Lecture		Tut	orial	Lab Pra	ctice	Tota	1	
per week	3		1		-		4		
Pre-requisite	Basic know	Basic knowledge in linear models and their properties							
Objectives of the	The main of	The main objectives of this course are to:							
Course	1. To lea	arn th	ne an	alysis of su	rvival data	a.			
	2. To dis	sting	uish	censored an	nd uncenso	ored d	ata.		
	3. To vis	suali	ze an	d communi	icate time-	-to eve	ent dat	a, to fit and	
	interp	ret fa	ailure	e time mode	<u>el.</u>	1	0		
Course Outline		once	pts c	of time, Or	der and ra	indom	Cens	oring, likelihood in	
	these case	S.	Life	Lincon Ec	ons- Exp	Donen	tiai,	Gamma, Weibull,	
	Lognorman,	Par	$e_{\rm IO}$,	іліеаг га	inure rate	. Para	ametri	c interence (Point	
		$\frac{\text{score}}{\text{ifo} t}$	$\frac{28}{28}$	LE)	0 m00n r	viduo	l lifa a	nd their elementery	
	proportion	fie ta	autes	of Again		of A	aoing	alassas and their	
	properties.	nd r	elatic	on Agenia	g, Types	Bath	tub E	classes allu ulell	
	of Inverse F	litti i Tazar	d rat	e octw		, Dam		indre rate, concept	
	INIT III.	Fstir	natio	on of surviv	al functio	n Act	uarial	Estimator Kanlan-	
	Meier Estin	ator	Esti	imation unc	ler the ass	umnti	on of]	FR / DFR Tests of	
	exponential	itv a	, <u>Lou</u> again	st non- p	arametric	class	es- T	otal time on test.	
	Despande te	est.		or non p		•••••			
	UNIT IV:	Tw	o sa	mple prob	lem- Geh	an tes	t, Log	g rank test. Mantel	
	Haenszel te	est,	Taro	ne Ware 1	tests. Intro	oducti	on to	Semi- parametric	
	regression f	for fa	ailur	e rate, Cox	's proport	tional	hazar	ds(PH) model with	
	one and sev	ral	cova	riates and	estimation	probl	lems in	n Cox's PH Model.	
	Rank test fo	or the	regr	ession coef	ficients.	-			
	UNIT V:	Intro	oduct	tion to Co	ompeting	risks	analy	sis and estimation	
	problems ir	n cor	npeti	ing risk mo	odel for p	arame	etric a	nd non- parametric	
	semi param	etric	set	up. Ideas	of Multip	le dec	remen	t life table and its	
	applications	5.							
Extended Professional	Questions	relat	ed t	the abo	ove topics	s, fro	m va	rious competitive	
Component (is a partof	examinatior	ns Ul	PSC	/ TRB / N	ET / UGO	C - C	SIR /	GATE / TNPSC /	
internal	applied sur	rvey	tec	hniques a	dopted in	n Eco	onomi	es and Statistics	
component only, Notto	department	of Ta	amil	Nadu State	Governm	ent.			
be included in the									
External Examination	(To be discu	issed	l duri	ing the Tuto	orial hour)				
question paper)									
Skills acquired from	Knowledge,	, ,	Prob	lem Solvi	ng, Analy	tical a	bility,	Professional	
this course	Competence	y, Pro	ofess	ional Comr	nunicatior	n and 7	Fransf	errable Skill	
Recommended	1. Mill	er, R	.G. (1981): Surv	vival analy	sis (Jo	ohn W	iley).	
Text Books	2. Cox	, D.F	R. and	d Oakes, D.	(1984) : 4	Analys	sis of S	Survival Data,	
	Cha	pmar	n and	Hall, New	York.	-			

Reference Books	1. Elisha T Lee, John Wenyu Wang and Timothy
	Wenyu Patt (2003): Statistical Methods for Survival data
	Analysis, 3/e, whey inter Science.
	2. Gross, A.J. and Clark, V.A. (1975) : Survival distribution :
	Reliability applications in the Biomedical Sciences, John
	Wiley and Sons.
	3. Elandt Johnson, R.E. Johnson N.L.: Survival Models and
	Data Analysis, John Wiley and sons.
	4. Kalbfleisch J.D. and Prentice R.L.(1980), The Statistical
	Analysis of Failure Time Data, JohnWiley.
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for this
e-Learning Source	subject.

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	Μ	М	М	S	М	S	М	М
CO2	S	S	S	S	М	S	М	S	М	М
CO3	S	S	S	М	S	S	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

S-Strong, M-Medium, W-Weak

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0



Econometrics

Title of the C	ourse	Econometrics							
Paper Numb	er	Χ							
Category	ED	Year	Ι	Credits	3	Cou	rse		
		Semester	II	-		Cod	e	23PSTME10	
Instructional	Hours	Lecture	Tu	torial	Lab Pra	ctice	Tota	al	
per week		3	1		-		4	-	
r Pre-requisite		Basic knowledge in linear models and their properties							
Objectives	of the	The main c	biectiv	ves of this c	ourse are	to:	<u>prop</u>		
Course	or the	1. Deve	elop kn	owledge of	n concepts	s of m	ethod	ology, nature and scope of	
		Ecor	nometri	ic analysis	1				
		2. Incu	lcate th	ideas of a	application	ns of e	econo	metrics	
		3. Unde	erstand	and explor	re the cond	cepts	of line	ear models	
		4. Expl	ore pro	ominent est	imation m	ethod	ls for	linear regression model	
		and	simulta	neous equa	ation mode	els.			
Course Outli	ne	UNIT I:	Nature	e and sco	pe of Ed	conon	netric	s - Illustrative Examples	
		Production	and c	ost analysi	is - Theor	ry and	d ana	lysis of consumer demand	
		specification	on - Est	timation of	demand f	unctio	on-Pr	ice and income elasticity of	
		inferior go	Price (dels buildi	of supply	/ - 10	orquiv	vists model of demand for	
			Single	equation 1	inear mod	el· st	$\frac{1}{\text{atic c}}$	ase - Ordinary least square	
		model and	gener	alized leas	t squares	mode	l: Int	roduction - estimation and	
		prediction	- Prob	lem of mu	lti collinea	arity a	and h	eteroscedasticity - Causes,	
		consequen	ces and	l solutions	of and esti	matic	on.	-	
		UNIT III:	Auto	correlation	: Causes,	cons	equer	nces and testing for auto-	
		correlated	disturb	ances - Au	toregressi	ve sei	ries o	f order 1 (AR(1)) - Lagged	
		Variables a	and di	stributed le	og metho	ds -	Error	's in variable models and	
			al valla Sim	ultaneous	onnear ro	mode	$\frac{\text{lng}}{1}$	ncept structure and types -	
		Identificati	on Pro	blem with	restriction	noue	varia	nce and covariance - Rank	
		and order of	conditio	ons of iden	tifiability	-Met	hods	of estimation- Indirect least	
		square met	hod, tv	vo-stage lea	ast squares	s metl	hod o	f estimation and Estimation	
		of Limited	Inform	nation Max	imum Like	elihoo	od (LI	ML).	
		UNIT V: K-Class estimators - Full information estimators - Full							
		Information	n Max	$\lim_{n \to \infty} L_1 k$	elihood (FIMI	_) -	Three stage least squares	
		methods	(3-3L)	s) and its	Properties	5 - CC	mpa	ison of various estimation	
Extended		Questions	related	l to the	above	topics	fre	om various competitive	
Professional		examination	s UPS	C / TRB / I	NET / UG	C - C	'SIR /	GATE / TNPSC / applied	
Component (i	s a part	survey tech	niques	adonted in	Economic	rs and	l Stat	istics department of Tamil	
of internal	1	Nadu State (Govern	ment	Leononin	cs and	i Diui	istics department of Tunin	
component on	ly, Not		JUVCIII	inicint.					
to be included	1 in the	(To be discu	uccad d	uring the T	utorial ho	ur)			
External Exar	nination		isseu u	uning the 1	utoriai 1101	ui <i>)</i>			
question pape	r)								
Skills acquir	ed	Knowledge,	Pr	oblem So	lving, Ana	alytica	al abi	lity, Professional	
from this cou	rse	Competency	, Profe	essional Co	mmunicat	ion ar	nd Tra	ansferrable Skill	

Recommended	1. Castle, J. and Shephard, N. (2009) The Methodology and Practice
Text Books	of Econometrics. Oxford University Press, London.
	2. Goldberger, A.S. (1964) Econometrics theory, Wiley, New York.
Reference Books	1. Kelejion, H. H. and Oates, W.E. (1988) Introduction to
	Econometrics, Principles and Applications. Harper and Row,
	New York.
	2. Maddala, G.S. and KajalLagari. (2009) Introduction to
	Econometrics, Wiley, New York.
	3. Madnani, G.M.K. (2008) Introduction to Econometrics:
	Principles and Applications. Oxford and IBH, New Delhi.
	4. Wooldridge, J. (2012) Introduction Econometrics: A Modern
	Approach. Cengage Learning, New Delhi.
	5. Gujarati, D. N., Dawn C Porter and Sangeetha Kunasekar,
	(2016), Basic Econometrics, Fifth Edition, McGraw Hill
	Publisher, New York.
	6. Johnston, J., and J. Dinardo, (1997). Econometric Methods,
	McGraw-Hill.
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for this
e-Learning Source	subject.

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

- 1. Understand the basic concepts of Econometrics, methodology and limitations of using Econometric theory.
- 2. Derive Generalized Least square estimators and its properties.
- 3. Address the problem of violation of basic assumptions of GLS.
- 4. Find the solution for structural and reduced form models.
- 5. Obtain viable, reliable and optimal solution under simultaneous equation models.

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

Applied Regression Analysis										
Title of the Course				Applied R	egression A	nalys	is			
Paper Number	XI									
Categor ED	Year	Ι		Credits	3	Course Code				
У	Semester	Π						23PSTME11		
Instructional Hours	Lecture		Tuto	rial	Lab Pract	ice	Tota	1		
per week	3		1		-		4			
Pre-requisite	Basic skil	ls in	correl	ation and re	gression					
Objectives of the	The main of	obje	ctives	of this cours	se are to:					
Course	1. To c	leve	lop a d	leeper under	standing of	the li	near ar	nd non-linear		
	regression model and its limitations.									
	2. To l	earn	how t	o develop re	egression mo	odel a	nd app	oly for the		
	specific perspective data appropriate manner.									
Course Outline	UNIT I: Multiple Linear Regression. Estimation of Model parameters.									
	Least square estimation of the regression coefficients-properties of least									
	square es	tima	ators.	Maximum	likelihood	Est	imatio	n-Tests for the		
	significanc	e o	f regre	ession- Test	t on individ	ual r	egressi	on coefficients –		
	Confidenc	e in	terval	on the reg	ression coef	ficier	its- Co	onfidence interval		
	estimation	0	f m	ean Respo	onse-Predict	ion	-Stan	dard regression		
	coefficient	<u>S-U</u>	NII no	ormal scalin	g-UNIT leng	gth sc	aling.	tion of maiduals		
	UNIII:	K f sou	esidua	l analysis.	Definition	and]	proper	ties of residuals-		
	for lack of	f fi	ting r t Var	iance -Stab	ilizing trans	- r KI	tion_t	ransformations to		
	linearize	Mod	lels-Ge	eneralized	and weight	ed le	anon-u	auares Indicator		
	variables-c	conc	ent and	d use.	and weight	.cu n	Just s	quares. maleator		
	UNIT III	:	M	odel buildi	ng problem	-varia	ble S	election-Stepwise		
	regression	m	ethods	. Multicol	llinearity -	sou	irces	and effects of		
	multicollin	eari	ty -	-Diagnostic	s and	meth	nods	for detecting		
	multicollin	eari	ty.	Ū				0		
	UNIT IV:	I	Polyno	mial regres	sion. Polyno	omial	mode	l in one variable.		
	Piecewise	Pol	ynomi	al fitting	(Splines) -	Non	paran	netric regression.		
	Kernel reg	gress	ion –	Locally W	eighted regr	ression	n. Poly	ynomial model in		
	two or m	ore	variat	oles. Non-li	near regres	sion-r	non-lin	ear least square-		
	transforma	tion	to line	ear model-p	arameter est	imatio	on.	· · · · · ·		
	UNIT V:	(jenera	lized Linea	r Models (GLM). Log	sistic Regression-		
	Estimation	ot	param	eters in log	sistic regress	sion M	viodels	-Interpretation of		
	parameters	5 1N	logist	ic regressio	n models.	POISSO	on regi	ression-GLM-link		
	function a	nd li	near p	rediction- pa	arameter est	imatio	on in G	τLM.		

Extended Professional Component (is a partof internal component only, Notto be included in the	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.
External Examination question paper)	(10 be diseussed during the Futorial notif)
Skills acquired from this course	Knowledge, ProblemSolving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill
Recommended Text Books	 Montgomery. D.C. Peck E.A. Vining. G.G. (2003), Introduction to Linear Regression Analysis, John Wiley &sons, Inc, New York. Draper. N.R. and Smith. H. (1998) Applied regression Analysis, John Wiley.
Reference Books	 Montgomery. D.C. Peck E.A. Vining. G.G. (2003) Introduction to Linear Regression Analysis, John Wiley &sons, Inc, New York. Draper. N.R. and Smith. H. (1998) Applied regression Analysis, John Wiley Hosmer, D.W, Lemeshow, S., and Sturdivant, R. X. (2013) Applied Logistic Regression, Third Edition, John Wiley and Sons.

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	М	М	М	S	М	S	М	М
CO2	S	S	S	S	М	S	М	S	М	М
CO3	S	S	S	М	S	S	М	S	S	М
CO4	М	S	S	S	S	S	S	S	М	М
CO5	S	S	S	S	М	S	S	S	М	М

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.2.6 Group E:

Operations Research										
Title of the Course				Operatio	ns Rese	arc	h			
Paper Number	XII									
Category ED	Year	Ι	Credits	3	Course	e				
	Seme	Ι			Code		23PSTME12			
	ster									
Instructional Hours	Lectur	Lecture Tutorial Lab Practice Total								
per week	3	3 1 4								
Pre-requisite	Undergraduate Level Linear Programming Problems									
Objectives of the	1.	optimiza	ation techni	ques that	will be	usef	ful in the personal and			
Course	1	professi	onal life.				1			
	2.	2. To learn the mathematical formulation of complex decision-								
	1	making	problems a	nd arrives	s at optir	nal	or near-optimal solutions			
	1	using di	fferent tech	niques of	operatio	ons	research.			
Course Outline	UNIT	I: Mat	hematical	Programn	ning - S	Solv	ving of LPP by graphical			
	metho	d - Line	ar Program	ming Prol	blem (Ll	PP)-	-Simplex, Big M and Two			
	Phase	method	s –Solving l	LPP using	g Duality	/ - I	Dual Simplex method.			
	UNIT	II: Inte	ger Progran	nming Pro	oblem (l	IPP)) - Gomory's cutting plane			
	algorit	hm– Mi	xed IPP – H	Branch an	d Bound	1 tec	chnique.			
	UNIT	III: Dy	namic prog	ramming	problen	n (E	OPP) - Bellman's principle			
	of op	timality	- Genera	l formul	lation -		omputation methods and			
	applica	ation of	DPP - Solv	ing LPP t	hrough	DPI	P approach.			
	UNIT	IV: No	on Linear I	Programm	ning: Co	onst	rained and Unconstrained			
	Proble	ms of N	(laxima and	minima,	Constra	aint:	s in the form of equations			
	Ouadr	atic pro	victilou) a	Reale's ar	nd wolf's	s (1 s me	ethods simplex method for			
	quadra	tic prog	ramming.	beule 5 ui	ia won t	5 111	ethous simplex method for			
	UNIT	V: PE	RT - CPN	I: Applie	cations,	Ba	sic Steps in PERT/CPM			
	technic	ques; T	ime estima	ites and	Critical	Pa	th in Network Analysis;			
	Optim	um and	minimum d	luration c	ost, PER	RT, I	Resource Allocations.			
Extended Professional	Questions related to the above topics, from various competitive									
Component (1s a partof	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /									
internal component only Notto	others to	others to be solved								
be included in the	(To be d	discusse	d during the	e Tutorial	hour)					
External Examination										
question paper)										
Skills acquired from	Vnor	lades	Drohlam	Soluina	Anal-	tics	1 ability Drofossional			
Skills acquired from		etency	Professions	SOLVING,	Analy	uca	d Transferrable Skill			
this course		<u>, , , , , , , , , , , , , , , , , , , </u>								
Kecommended		Hillier h	'S and Libe	rmann GJ	(2002):	: Int	troduction to Operations			
Text Books		Kesearc	11, 1 Edition	II, MCGra	1W H111.		(2004): Operations Descent			
	<i>Z</i> .	nanti3V 1	arup,P.K.C	Juptaand	vianivior	ian(2004):OperationsResearc			
		ll, Sulton (hand and C	one New	Dolh:					
	'	Suitan	manu anu S	ons, new	Deim.					
	3.	Gross D	, Shortle J.	F., Thor	npson J.	.M.	and Harris C.M. (2011):			
		Fundam	entals of Q	ueuing Th	neory, Jo	ohn	Wiley & Sons			

Reference Books	1. Sinha SM(2006):Mathematical Programming: Theory and
	Methods, Elsevier Publications.
	2. Devi Prasad (2015), Operations Research, Narosa Publishing
	House
	3. Kapoor V.K.(2008):Operations Research, 8/e,SultanChand&Sons
	4. Sharma .S.D(1999): Operation Research , Kedar Nath RamNath &
	Co., Meerut.
	5. Hamdy A.Taha(1987):Operations Research – An Introduction, 4
	/e, Prentice Hall of India, PrivateLtd,NewDelhi.
	6. Sujit K. Bose (2012), Operations Research Methods, 2/e, Narosa
	Publishing House
	7. K. Chandrasekhara Rao and Shanti Lata Misra (2012), Operations
	Research, Narosa Publishing House
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform
e-Learning Source	for thissubject.
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After the successful completion of the course, the students will be able to:

- 1. Understand basics and formulation of linear programming problems and appreciate their limitations; solve linear programming problems using graphical method.
- 2. Apply simplex method to solve real life problems.
- 3. Solve artificial variable technique, duality theory, revised simplex method, sensitivity analysis, transportation and assignment problems.
- 4. Understand the concept of Game theory, PERT/ CPM, simulation, investment analysis with real life applications.

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0



Database Management Systems

Title of the Course	Database Management Systems										
Paper Number	XIII										
Category ED	Year I	Credits	3	Cou	rse						
	Semester II			Code	e	23PSTME13					
Instructional Hours	Lecture	Tutorial	Lab Pra	ctice	Tota	1					
per week	3	1	-		4						
Pre-requisite	Basic knowledge in linear models and their properties										
Objective of the	The main obje	ectives of this co	urse are to):							
Course	1. To Und	erstand the basic	concepts	and th	he app	olications of					
	database	e systems									
	2. To Mas	ter the basics of	SQL and	constr	uct qu	ieries using SQL					
	3. To unde	erstand the relation	onal datab	base de	esign j	principles					
	4. 10 beco	ome familiar with	n the basic	c issue	es of tr	ansaction					
	5 To been	ing and concurre	ency contr	01	ao atm	uctures and					
	J. TO beco	echniques	I uatabase	stora	ge sut	letures and					
Course Outline	UNIT I: Da	ta base Syster	n Applic	ations	, Pur	pose of Database					
	Systems, View	v of Data – Dat	a Abstrac	tion. I	Instan	ces and Schemas –					
	data Models -	- the ER Model	– Relati	onal N	Aodel	- Other Models -					
	Database La	nguages – DD	DL - DN	ML -	- data	abase Access for					
	applications	Programs – da	ata base	Users	s and	Administrator –					
	- the Ouerv	lanagement – da Processor Data	ita base de	sign 3	cture -	– Storage Manager					
	Model - Enti	ities. Attributes	and Ent	itv se	ets –	Relationships and					
	Relationship s	ets – ER Design	n Issues –	Conc	ept D	esign – Conceptual					
	Design for Un	iversity Enterpri	ise. Introd	luction	to th	e Relational Model					
	– Structure – I	Database Schem	a, Keys –	Schen	na Dia	agrams.					
	UNIT II: R	Relational Quer	y Langu	ages,	Rela	tional Operations.					
	Relational A	lgebra – Selec	tion and	proje	ection	set operations –					
	renaming – J	010s - Division	ı – Exam	ples (of Alg	gebra overviews –					
	calculus Over	view of the SO	[Ciational]	Calcu I angu	age -	Basic Structure of					
	SOL Oueries.	Set Operations	. Aggrega	ate Fu	nctior	is – GROUPBY –					
	HAVING, Ne	sted Sub queries	, Views, 7	Frigge	rs.						
	UNIT III: No	ormalization – In	troduction	n, Nor	n loss	decomposition and					
	functional dependencies, First, Second, and third norm										
	dependency p	reservation, Bo	yee/Codd	norm	al for	m. Higher Normal					
	form Join don	auction, Multi-	alued dep	pender	ncies :	and Fourth normal					
	101111, John dep	endencies and F	nun norm	ai 1011	11.						

	UNIT IV: Transaction Concept- Transaction State- Implementation of									
	Atomicity and Durability - Concurrent -Executions - Serializability-									
	Recoverability – Implementation of Isolation – Testing for serializability-									
	Lock –Based Protocols – Timestamp Based Protocols- Validation- Based									
	Protocols – Multiple Granularity.									
	Recovery and Atomicity – Log – Based Recovery – Recovery with									
	Concurrent Transactions – Buffer Management – Failure with loss of									
	nonvolatile storage-Advance Recovery systems- Remote Backup systems.									
	UNIT V: File organization: File organization – various kinds of indexes.									
	Query Processing – Measures of query cost - Selection operation									
	Projection operation, - Join operation – set operation and aggregate									
	operation – Relational Query Optimization – Transacting SQL queries –									
Enternale d Durche and an al	Estimating the cost – Equivalence Rules.									
Extended Professional	Questions related to the above topics, from various competitive									
Component (1s a partor	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /									
internal component only Notto	applied survey techniques adopted in Economics and Statistics									
be included in the	department of Tamil Nadu State Government.									
External Examination										
question paper)	(To be discussed during the Tutorial hour)									
question puper)										
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional									
this course	Competency, Professional Communication and Transferrable Skill									
Recommended	1. Data base System Concepts, Silberschatz, Korth, McGraw hill,									
Text Books	Sixth Edition.									
	2. Data base Management Systems, Raghurama Krishnan, Johannes									
	Gehrke, TATA McGraw Hill 3 rd Edition.									
	1. Fundamentals of Database Systems, Elmasri Navathe Pearson									
Reference Books	Education.									
	2. An Introduction to Database systems, C.J. Date, A.Kannan,									
	S.Swami Nadhan, Pearson, Eight Edition.									
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for this									
e-Learning Source	subject.									

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

- 1. Demonstrate the basic elements of a relational database management system
- 2. Ability to identify the data models for relevant problems
- 3. Ability to design entity relationship and convert entity relationship diagrams into RDBMS and formulate SQL queries on the respect data
- 4. Apply normalization for the development of application software's

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

СО /РО	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	3.0	5.0	3.0	3.0

Elective VI to be chosen from Group F

11.2.7 Group F:

Non - Parametric Inference

Title of the	Course	Non - Parametric Inference							
Paper Num	ber	XIV							
Category	ED	Year	II	Credits	3	Cou	rse		
		Semester	IV			Code	9	23PSTME14	
Instructiona	al Hours	Lecture	Tut	orial	Lab Practice		Tota	1	
per week		3				4			
Pre-requisit	te	Undergraduate Level Non – Parametric methods							
Objectives	of the	1. To familiariz	1. To familiarize the concepts of non- parametric tests						
Course		2. To Character	rize, c	ompare, and	contrast di	ifferen	t		
		non-parame	non-parametric hypothesis tests.						
		3. To Present a	nd co	mmunicate, l	both orally	and in	n writte	en-	
		form, the res	sults c	of statistical a	analyses of	non-p	arame	tric	
		data.							
Course Out	line	UNIT I: Nonpara	ımetri	c vs. Paran	netric stati	stical	tests	- Fundamental	
		differences - Appro	opriat	e situations	for use of	nonpa	ramet	ric methods vs.	
		Power-efficiency of	.s - A f noni	uvaillages ai	iu uisauva	inages	or pa nilar n	arametric tests -	
		INIT II. The one sample case Pinomial tost Chi Square tost for							
		goodness of fit, Kolmogorov -Smirnov test, runs test.							
		UNIT III: The case of two related samples – McNemar, Sign. Wilcoxon.							
		Walsh tests - The case of two independent samples - fisher exact-							
		probability test, C	'hi-Sq	uare test fo	r independ	dent s	amples	s, Median test,	
		Mann-Whitney U-t	est, K	lolmogorov-	Smirnov te	st, Wa	ld-Wo	olfowitz test.	
		UNIT IV: The ca	se of	k related sa	mples - C	ochrar	ne Q -	test, Friedman	
		two-way analysis o	of vari	iance by ranl	ks. The cas	se of k	indep	endent samples	
		Chi-Square test f	or k	independen	it samples	, Kru	skal-V	Vallis one-way	
		UNIT V. Nonpar	e by fa	aliks. ric correlatio	on the	contin	ganov	coefficient C	
		Spearman rank correlation							
		Kendall rank co	rrelat	ion, Kenda	ll partial	corre	lation	coefficient -	
		nonparametric line	ar reg	ression.	I				
Extended Pro	fessional	Questions related	to	the above	topics, fi	rom	variou	s competitive	
Component (i	is a partof	examinations UPS	С / Т	RB / NET	/ UGC –	CSIR	/ GA7	TE / TNPSC /	
interna	al	others to be solved							
component or	nly, Notto	(To be discussed du	uring	the Tutorial	hour)				
be included in	n the		_						
External Exar	nination								
question pape	er)			~ 1 .			_		
Skills acqui	red	Knowledge, Prol	blem	Solving,	Analytical	abili	ity, F	Professional	
from this co	ourse	Competency, Profe	ession	al Communi	cation and	Trans	terrabl	le Skill	

Recommended	1. A Distribution-Free Theory of Nonparametric Regression									
Text Books	(Springer Series in Statistics) Paperback – Import, 4									
	December 2010.									
	2. Gibbons J.D. (1971): Nonparametric Inference, McGraw-Hill.									
Reference Books	 Hardle (1990): Applied Non-parametric Regression, Cambridge University Press. 									
	2. Hart J.D. (1997): Non-parametric Smoothing and Lack of Fit Tests, Springer Verlag.									
	 Takezawa K. (2005): Introduction to Non-parametric Regression - Wiley Series in 									
	Probability and Statistics, John Wiley and Sons.									
Website and	e-books, online tutorials taken from MOOC/SWAYAM platform for									
e-Learning Source	thissubject.									

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

- 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)

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

S-Strong, M-Medium, W-Weak

CO /PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0



Title of the	e Course	Reliability Theory									
Paper Nun	nber	XV									
Category	ED	Year	II	Credits	3	Cou	rse				
		Semester	IV			Code	e	23PSTME15			
Instruction	nal Hours	Lecture	Tutorial		Lab Practice Tot		Tota	1			
per week		3	3 1 - 4								
Pre-requis	ite	Undergraduate Level Probability distributions & Queueing models.									
Objectives	of the	1. Provi	ide ar	insight int	o various t	ools a	nd tecl	hniques of			
Course		Relia	bility								
		2. Review the various mathematical, physical and logical									
		modeling tools for estimation and evaluation of component and									
		syste	m lev	el reliabilit	у.	1.1					
		3. Appr	aise f	allure phen	omena and	1 there	by pro	ovide valuable			
		stand	s IOF	product des	ign to ach	leve m	igner i	evers of reliability			
			ssmei	nt and evalu	ation of re	liahili	tv ơna	ls and their			
		impro	ovem	ents.		muom	ty gou				
Course Out	line	UNIT I: In	NIT I: Introduction to Reliability and its needs: Structural properties								
		of coherent system: components and systems, coherent structures,									
		representation of coherent systems in terms of paths and cuts, relevant									
		& irrelevan	it stru	icture; Mod	ules of co	herent	t syste	ms; Reliability of a			
		System Rel	iabili	s, Renadini tv	y importa	nce of	i com	ponents; bounds on			
		UNIT II: I	Life D	or Distributions	: Concept	of dis	stribut	ion function, hazard			
		function, R	Reliab	ility functi	on, MTTH	F, Bat	htub f	failure rate; loss of			
		memory pr	opert	y of Expon	ential distr	ibutio	n – pa	rametric families of			
		some comm	non l	ite distribut	ions – Ex	ponen	itial, V	Verbull and Gamma			
		models.	acter	izatioli - Ke	enability e	stimat	1011 01	parameters in these			
		UNIT III:	Notio	ons of Age	ng; Classe	es of l	life dis	stributions and their			
		duals - pres	servat	ion of life o	listribution	n class	es for	reliability operation			
		- Formation	n of co	oherent syst	ems, conv	olutio	ns and	mixtures.			
		UNIT IV:	Univa	ariate stock	models an	d life	distrib	utions arising out of			
		them: cumulative damage model, shock models leading to univariate									
		IFR, Successive shock model; bivariate shock models; common									
		bivariate exponential distributions due to shock and their properties.									
		systems: m	systems: modeling of a repairable system by a non-homogeneous								
		Poisson pro	cess.		1	<u></u>					

	UNIT V: Stress-Strength reliability - Concepts and its estimation for exponential, Weibull and gamma distributions; Reliability growth models; probability plotting techniques; Hollander – Proschan and Despande tests for exponentially – Basic ideas of accelerated life testing.								
Extended Professional	Questions related to the above topics, from various competitive								
Component (is a partof	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /								
internal	others to be solved								
component only, Not to be	(To be discussed during the Tutorial hour)								
included in theExternal									
Examination									
question paper)									
Skills acquired from	Knowledge, Problem Solving, Analytical ability,								
this course	Professional								
	Competency, Professional Communication and Transferrable Skill								
Recommended	1. Barlow, R.E. and Proschan F. (1985) Statistical Theory of								
Text Books	Reliability and Life Testing; Rinehart and Winston.								
	2. Lawless, J.F. (2003): Statistical Models and Methods of Life								
	Time Data; John Wiley.								
Reference Books	1. Bain L.J. and Max Engelhardt (1991): Statistical Analysis of								
	Reliability and Life Testing Models; Marcel Dekker.								
	2. Nelson, W (1982): Applied Life Data Analysis; John Wiley.								
	3. Zacks, S(1992): Introduction to Reliability Analysis,								
	Springer Verlag.								
	4. Marshall, A.W. and Olkin I(2007): Life Distributions, Spring								
Website and	e-books, online tutorials taken from MOOC/SWAYAM								
e-Learning Source	platform for this subject.								
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After the successful completion of the course, the students will be able to:

- 1. Develop an appreciation of basic terminologies as applied to reliability.
- 2. Enhance ability to design systems and process for reliability improvement.
- 3. Analyze failure phenomenon of components and systems so as to develop strategies for eliminating/minimizing product failures.
- 4. Generate estimates for reliability through different modeling approaches for component and system level reliability in real life contexts.

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

CO-PO Mapping (Course Articulation Matrix)

S-Strong, M-Medium, W-Weak

СО /РО	PSO1	PSO2	PSO3	PSO4	PSO5
C01	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	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

11.3 Skill Enhancement Courses SEC:

11.3.1 Practical I – (Based on R Programming)

Title of the Course		Practical I – (Based on R Programming)						
Paper Nur	nber	Ι						
Category	SEC	Year	Ι	Credits	2	Cou	rse	
		Semester	Ι			Cod	e	23PSTCP01
Instruction	nal Hours	Lecture	Tu	torial	Lab Pra	ctice	Tota	al
per week		1	-		1		2	
Pre-requis	site	Fundamen	nentals of Sampling Techniques and Distribution Theory					
Objectives	s of the	The main objectives of this course are to:						
Course		1. Understand the notions of Sampling by using R.						
		2. Impart application of Distribution Theory in various						
		doma	ins.					
Course Ou	ıtline		-					
		1 0'	(Core II. Sai	mpling T	heory	•	
		I. Sim	ple rando	om samplin	g methods	s of di	awin	g sample –
		Estimation of the population total and variance estimation.						
		2. Linear and circular systematic sampling 3. Stratified sampling SPS DPSWD DPSWOP						
		5. Summed sampling $-$ 5K5, PF5WK, PF5WOK 4. Cluster sampling $-$ of equal sizes						
		5 Ratio Regression and Difference estimation estimators						
		 6. PPSWR – Hurwitz Thompson estimator. 						
		r · · · · · · · · · · ·						
		Core III Distribution theory						
		7. Truncated Binomial, Poisson and Normal distributions						
		8. Compound Binomial, Poisson and Normal distribution					istributions.	
		9. Llife	e distribu	tions: expo	nential, W	Veibul	1.	
		10. Mill	sratio, di	stributions	classified	by ha	zard	rate
		11. Graj	phing the	distributio	n of order	statis	stics	
Recommen	nded	1. Quie	ck, J. M.	(2010). Sta	tistical A	nalysi	s with	ı R, Packt
Text Book	S	Pub	lishing L	td., UK.		1	-1-1- 0	D (2000)
		2. Purc	onit, S. G	., Gore, S.	D., and Do	esnmu	ikn, S	. К. (2009).
		3. Dals	gaard. P.	(2008). Int	roductorv	Statis	tics w	vith R.
		Seco	ond Editi	on, Springe	er			,

Reference Books	 Everitt, B. S., and Hothorn, T. (2010). A Handbook of Statistical Analyses Using R, SecondEdition, Chapman and Hall, CRC Press. Crawley, M, J. (2007). The R Book, John Wiley and Sons Private Ltd., NY. 												
Website and	1. https://swayam.gov.in/nd1_noc19_ma33/preview.												
e-Learning Source	2. https://swayam.gov.in/nd2_aic20_sp35/preview.												
	3. https://nptel.ac.in/courses/111/104/111104100/												
Title of the	$\frac{Course}{Course}$	Practical II – (Based on R Programming)											
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Paper Num	her	IT	1140			1105141	iiiiiiiie						
Category	SEC	Year	I	Credits	2	Соц	rse						
curegory		Semester	II			Cod	e	23PSTCP02					
Instruction	al Hours	Lecture	T	utorial	Lab Pr	actice	Tota	1					
per week		1			1		2						
Pre-requisi	te	Basic knowledge of Estimation theory & Time Series Analysis											
Objectives	of the	The main objectives of this course are to:											
Course		1. Underst	1. Understand the notions of Estimation theory by using R.										
		2. Impart a	applicati	on of Time Se	eries Anal	ysis in v	arious	domains of R.					
Course Out	tline	•											
				Core IV: E	stimation	theory							
		1. MLE	and Sta	ndard error of	f ML estir	nators.							
		2. MLE	through	the method of	of success	ive appro	oximat	ion.					
		3. MLE for truncated distribution.											
		4. Meth	4. Method of Moments										
		5. Meth	5. Method of Minimum Chi-square										
		6. Meth	od of Le	east square	anaa inta	multon r							
		7. Interv	val estin	ation: Conno	ence inter	rval for f	nean,						
		o. Interv	val estin	ation - varian	ce and rai	tio of va	riances	Y					
		J. Inter	vai estili				nance	,					
				Core VI: Tin	ne Series	Analysi	S						
		10. Stand meas Relat Mear 11. Smoo expor 12. Tripl 13. Auto 14. Partia 15. Portm	analy Mean percent othing s metho	ysis: Absolute n square error. entage error, ng. Double hod).									
Recommend Text Books	ded	 Quick Ltd., Purol Using Dalga Edition 	k, J. M. UK. nit, S. G g R, Nar aard, P. on, Sprin	(2010). Statist ., Gore, S. D., osa (2008). Introd nger	tical Anal and Desh uctory Sta	ysis with nmukh, S atistics w	n R, Pa S. R. (2 with R,	ckt Publishing 009). Statistics Second					

11.3.2 Practical II – (Based on R Programming)

Reference Books	1.	Everitt, B. S., and Hothorn, T. (2010). A Handbook of Statistical
		Analyses Using R, SecondEdition, Chapman and Hall, CRC
		Press.
	2.	Crawley, M, J. (2007). The R Book, John Wiley and Sons Private
		Ltd., NY.
Website and	1.	https://swayam.gov.in/nd1_noc19_ma33/preview.
e-Learning Source	2.	https://swayam.gov.in/nd2_aic20_sp35/preview.
U	3.	https://nptel.ac.in/courses/111/104/111104100/

11.3.3 Practical III – (Based on Python)

Title of the	Course	Practical III – (Based on Python)								
Paper Num	ber	III								
Category	SEC	Year	Π		Credits	2	Cou	rse		
		Semester	III				Cod	e	23PSTCP03	
Instruction	al Hours	Lecture	Tutorial Lab Practice T		Tota	Total				
per week		1		-		1		2		
Pre-requisi	te	Basic knowledge of Testing Statistical Hypothesis, Multivariate Statistical Analysis & Time Series Analysis								
Objectives	of the	The main objectives of this course are to:								
Course		 Underst Python. Impart a Learn ar Analysis 	and th applic ad wr s thro	he no cation rite cu ough I	tions of Test of Linear M istomized pr Python.	ing Statisti lodels in Py ogram for l	ical Hy ython. Multiv	ypothes variate	sis by using Statistical	
Course Out	line			Cor	re VII: Test	ing Statisti	ical H	ypothe	esis	
		 Construction of randomized and nonrandomized MP, UMP and UMPU tests of hypotheses and drawing the power curves. Construction of SPRT and its OC and ASN curves. Non parametric tests: Kolmogorov Smirnov test, Mann-Whitney U test, Median test for k-sample problem, Kruskal Wallis test and Friedman's test 								
					Core VIII:	Linear Mo	odels			
		 Fitting Logit and Probit Models. Decisions based on deviance and Goodness of fit. Framing reduced model, null model and saturated model. Describing linear models- 1-way classification, 2- way classification, 3-way classification – main and interaction effects - Models not of full rank. 								
		Core IX: Multivariate Statistical Analysis								
		 7. Test f unkno 8. Test f 9. Discr 10. Cano 11. One V 	for eq own (for Ty imina nical Way]	juality (Hote wo Co ant Au corre MAN	y of mean ve lling's T ² tes ovariance ma nalysis elation and ca OVA with F	ectors when st) atrices anonical va Post hoc tes	n covar ariable sts (DN	riance : s MRT ai	matrix is nd Tukey's).	

	12. Principal Component Analysis
	13. Factor Analysis
D	1 Dethan fan Deta Analasia har O'Deiller Madie (Gerend Edition)
Recommended	1. Python for Data Analysis by O Relly Media (Second Edition).
Text Books	2. How to think like a computer scientist learning with Python by
	Allen Downey
	3. Python for Data Analysis by Armando Fernandgo
Reference Books	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, Apress,
	2010.

Title of the	Course	Practical IV- (Based on Python)								
Paper Num	ıber	IV								
Category	SEC	Year	II	Credits	2	Cou	rse			
		Semester	IV			Code	e	23PSTCP04		
Instruction	al Hours	Lecture	r	Tutorial	Lab Pr	actice	Tota	1		
per week		1		-	1		2			
Course Out	tline						I			
		CORE XI: Design of Experiments								
		1. M (I 2. M 3. M 4. 2 5. F 6. C 7. P 8. S 9. B 10. Y 11. A 12. A	fultiple LSD) te fissing fissing fissing artial c artial c plit plo IBD fouden .nalysis .nalysis	e Comparison t est, Bonferonn Data Analysis Data Analysis ctorial experim al factorial exp te confounding in onfounding in ot design Square Design s of Covariance	tests (Leas i's test) - one and - one and hents periments g in 2^4 , 3^2 2^4 , 3^2 fact he - CRD - e - RBD -	two obse two obse two obse factorial torial exp - One Co - One Co	cant D ervatio ervatio experi perime: oncomi	ifference ns in RBD ns in LSD ments nts tant Variable tant Variable		
		13. M L 14. M	farkov imiting 1/M/1 a	CORE XII: chains – High distribution and M/M/S que	Stochasti er order tr	c Proces	s Probat	pilities-		
		11.10	1/1 /1 /1 C							
Recommen Text Books	ded	 Python for Data Analysis by O'Reilly Media (Second Edition). How to think like a computer scientist learning with Python by Allen Downey Python for Data Analysis by Armando Fernandgo 								
Reference I	Books	 3. Python for Data Analysis by Armando Fernandgo 1. H. Brian, A Practical Introduction to Python Progra Creative Commons Attribution, 2012. 2. A. Saha, Doing Math with Python: Use Programm Explore Algebra, Statistics, Calculus, and More!, N Press, 2015 3. T. Hall, J. P. Stacey, Python 3 for absolute beginne 2010. 								

11.3.4 Practical IV - (Based on Python)

11.4 Non Major Elective Course (NME):

For the other Departments (not for Statistics Students)

11.4.1 Statistics for Life Sciences

Title of the	Course	Statistics For Life Sciences									
Paper Num	ber	Ι									
Category	NME	Year	Year Credits 2		2	Course					
		Semester	ster Code								
Instruction	al Hours	Lecture	Tu	torial	Lab Prac	tice	Tota	1			
per week		2	1				3				
Pre-requisit	te	Basics in Pr	Basics in Probability distributions, sampling, testing of hypotheses.								
Objectives	of the	The main ol	ojectives (of this course	are to:						
Course		1. Unde	1. Understand the application of statistics in Life sciences								
		2. To learn the Biological Assays.									
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		3. Attain proficiency categorical data analysis.									
Course Out	line	Unit I: Sta	tistical M	lethods in C	linical Tria	als: In	troduc	tion to clinical			
		trials sim	s pliases	I, II, III all mized desi	u IV, Stati on stratifi	stical	uesign	ized crossover			
		design: Se	auential	design - (	open and	close	e seat	iential design.			
		Randomization Dynamic randomization, Permuted block randomization									
		Blinding-Si	ngle, doul	ole and triple	•						
		Unit II: Bio	ological A	ssays: Introc	luction, par	allel-l	ine ass	say, slope- ratio			
		assays and	quantile-	response as	say, Fellei	r's the	orem.	Dose-response			
		relationship	s-qualitat	ive and qu	antitative	respo	nse,	dose response			
		Unit III. C	ategorical	$\frac{1}{Data} \Delta nalv$	sis: Catego	rical r	espone	arysis.			
		regression-c	odds ratio	bata Miary	statistic. le	ogistic	regre	ession and its			
		diagnostics, - Poison regression – Estimation of relative risk and its									
		applications	5.	-							
		Unit IV: R	OC Curve	e analysis - I	Estimation	of Bir	omial	Model and the			
		Area under	the Cur	ve, its applie	cations – I	Proper	ties of	f ROC curve -			
		Kullback	-Leibler	Divergence	(KLD)-	defi	nition	– functional			
		relationship	between	Kullback –L	eibler Dive	ergenc	e and	the slope of the			
		ROC curve – derivations of KLD expressions for Bi-normal R									
		model.									
		Data –Meas	sures of di	sease freque	ncv - incid	ence –	y and - preva	lence – relative			
		risk – Epidemiological study designs – Cohort study design and its									
		analysis – C	Case contr	ol study desi	gn and its	analys	is - cc	oncept of bias –			
		information	bias and	selection bia	s.						

Extanded Professional	Questions related to the shows taxing from various compatitive						
Extended Professional	Questions related to the above topics, from various competitive						
Component (is a part of	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /						
internal component only,	others to be solved (To be discussed during the Tutorial hour)						
Notto be included in the							
External Examination							
question paper)							
Skills acquired from	Knowledge, Problem Solving, Analytical ability, Professional						
this course	Competency, Professional Communication and Transferrable Skill						
Recommended	1. Myra L. Samuels, Jeffrey A. Witmer (2010): Statistics for Life						
Text Books	Sciences, 5 th edn,.						
	2. Andrew Schaffner, Jeffrey A. Witmer (2015): Statistics for Life						
	Sciences, Global edn.						
Reference Books	1. Anusha Illukkumbura (2021): Introduction to Categorical Data						
	Analysis.						
	2. Michael C. Whitlock, Dolph Schluter: The Analysis of Biological						
	Data, 2 nd edn. (2015) W. H. Freeman and Company. Ben Roberts						
	Pvt Ltd.						
	3 Elisa T Lee & John Wenvu Wang (2003): Statistical methods for						
	Survival Data analysis 3rd Edition John Wiley						
	2 Jarrold H. Zar (1000): Piostotistical Analysis, 4th adition						
	5. Jerrold H. Zar (1999): Biostatistical Analysis, 4th edition.						
	4. Armitage, P, Berry G and Mathews J.N.S (2002): Statistical						
	Methods in Medical Research, 4/e, Blackwell Scientific						
	Publications						
	5. Krzanowski, W and Hand, D.J.(2009): ROC Curves for						
	Continuous Data, Chapman and Hall						
Website and	1. https://www.academia.edu/43317940/The Analysis of Biological						
e-Learning Source	Data Second Edition.						

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

- 1. Use logical, mathematical and/or statistical concepts and methods to represent real world situations
- 2. Students understand basic concepts of statistics and probability
- 3. Students comprehend methods needed to analyze and critically evaluate statistical arguments.

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

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

S-Strong, M-Medium, W-Weak

СО /РО	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
C05	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course	3.0	3.0	3.0	3.0	3.0
Contribution to Pos	5.0	5.0	5.0	5.0	5.0

Title of the	Course	Optimization Techniques										
Paper Num	ber	II				-						
Category	NME	Year		Credits	2	Cour	rse					
		Semester				Code						
Instruction	al Hours	Lecture	Tut	orial	Lab Prac	tice	Total					
per week		2 1 3										
Pre-requisi	te	Basics in operations research.										
Objectives	of the	The main of	ojectives o	of this course	are to:							
Course		1. Under	rstand the	problem for	mulation b	y using	g linea	r, dynamic				
		progra	programming, game theory and queuing models									
		2. Acquire knowledge on stochastic models for discrete and										
		manufacturing models for the production decision making										
		3 Form	ulation of	mothematic	al models f	on dec	ntitatix	naking				
		3. Formulation of mathematical models for quantitative analysis of managerial problems in industry										
Course Out	tline	Unit I: De	velopmen	t. definition	. character	istics	and p	hases, types of				
		operation	research	models,	applicati	ons;	Alloc	cation: linear				
		programming, problem formulation, graphical solution, simplex method,										
		artificial variables techniques, two-phase method, big-M method.										
		Unit II: 7	Transport	ation proble	em: Form	ulatior	n, opt	imal solution,				
		unbalanced	transport	ation problem	m, Degene	racy;	Assign	ment problem,				
		formulation	, optimal	solution, var	iants of ass	signme	ent pro	blem, traveling				
		Init III.	Sequencin	g. Introduct	tion flow	shop	sean	encing n jobs				
		through tw	o machir	es. n jobs	through	three	machi	nes, job shop				
		sequencing,	and two j	obs through	"m" machi	nes.		J J I I				
		Unit IV: T	heory of	Games: Intr	oduction -	- Tern	ninolog	gy, Solution of				
		games with saddle points and without saddle points, 2×2 games,										
		dominance principle, m X 2 & 2 X n games, Graphical method.										
		<b>Unit v:</b> Waiting Lines: Introduction, Terminology, Single Channel, <b>Poisson</b> arrivals and exponential service times with infinite nonulation										
		and finite	populatic	n models,	Multichan	nel, F	Poissor	n arrivals and				
		exponential	service ti	mes with inf	inite popula	ation.						
Extended Pr	rofessional	Questions 1	related to	the above	e topics, t	from	variou	s competitive				
Component	(is a part of	examination	s UPSC /	TRB / NET	Г / UGC –	CSIR	/ GA'	TE / TNPSC /				
internal com	ponent only,	others to be	solved									
Notto be inc	cluded in the	(To be discu	ussed duri	ng the Tutori	al hour)							
duestion par	annnation per)			-	<i>,</i>							
Skills acou	ired from	Knowledge	, Proble	m Solving	Analytic	cal al	bility.	Professional				
this course	-	Competenc	y, Profess	ional Comm	unication a	ind Tra	nsferr	able Skill				

11.4.2 Optimization Techniques

Recommended	1.	J. K. Sharma, "Operations Research", Macmillan, 5th Edition,
Text Books		2012.
	2.	R. Pannerselvan, "Operations Research", 2nd Edition, PHI
		Publications, 2006
<b>Reference Books</b>	1.	M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations
		Research", Pearson Education, 2013.
	2.	Maurice Saseini, Arhur Yaspan, Lawrence Friedman, "Operations
		Research: Methods & Problems", 1 st Edition, 1959.
Website and	1.	https://www.aicte-
e-Learning Source		india.org/flipbook/p≈/Vol.%20II%20UG/UG_2.html#p=
	2.	https://www.britannica.com/topic/operations-research

- 1. Recall the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a L P Model Effectively interpret the results from the control charts
- 2. Identify appropriate optimization method to solve complex problems involved in various industries.
- 3. Find the appropriate algorithm for allocation of resources to optimize the process of assignment.
- 4. Explain the theoretical workings of sequencing techniques for effective scheduling of jobs on machines.

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

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

*S-Strong; M-Medium; L-Low

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

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					
<b>Course Contribution to</b>	3.0	3.0	3.0	3.0	3.0
Pos					

11.4.3	<b>Statistical Methods</b>
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Title of the	Course	Statistical Methods							
Paper Num	ber	III							
Category	NME	Year		Credits	2	Cou	rse		
		Semester				Cod	e		
Instruction	al Hours	Lecture	Tut	orial	Lab Prac	ctice	Tota	l	
per week		2	1				3		
Pre-requisi	te	Basics in Sta	atistics.						
Objectives	of the	The main ob	jectives o	of this course	e are to:				
Course		1.Understand	basic def	initions in s	tatistics.				
		2. To introduc	e basic co	oncepts in Sta	atistics and	develo	p data 1	reduction	
		techniques.							
Course Out	line	Unit I: Natu	ire and sc	ope of statis	tical metho	ds – L	imitati	ons – Types of	
		data – Class	Ification a	and tabulation	on of data –	Const	ruction	of frequency	
		distribution	– Diagrai		graphicarie	preser	nation	of data.	
		Unit II: Def	finitions –	Mean – Me	edian – Moo	de – G	eometr	ric mean –	
		Harmonic m	nean – Ch	aracteristics	of a good a	average	e – Me	rits and	
		demerits.			-	-			
		Unit III: Ra	inge – Qua	artile deviation	on – Mean o	leviatio	on and	their Marita and	
		demerits	– Standard	i deviation –	Coefficient	or var	lation -	- Merits and	
		Unit IV: De	finitions	– Types and	methods o	f meas	uring (	correlation -	
		Scatter diag	ram – Kai	l Pearson's	coefficient	of cor	relation	n – Spearman's	
		rank correla	tion co-ef	ficient, Part	ial and Mul	tiple C	Correlat	tion.	
		Unit V: Reg	gression –	on – Simple linear Regression equations – Method of					
		least squares	s – Multip	le Regressio	on – Simple	e Probl	ems.		
Extended Pr	ofessional	Questions 1	related to	the abov	e topics	from	variou	s competitive	
Component	(is a part of	examination		TRB / NE	T / UGC –	- CSIR		FE / TNPSC /	
internal com	ponent only,	chars to be solved							
Notto be inc	cluded in the	(To be discu	issed duri	ng the Tutor	ial hour)				
External Exa	amination	(10 be diset			iai noui)				
question par	per) incd from	Vnoviladaa	Duchlo	m Colvino	Analyti	<u>aa1 a</u>	h:1:+++	Drofossional	
Skills acqui	Irea Irom	Competency Professional Communication and Transferrable S							
this course	1.1		$\overline{\mathbf{y}, 1101033}$			14 (			
Kecommene Trant David	aea	ethods, Sultan Chand & Sons, New							
1 ext Books		2. Gupta. S.	. C. and K	apoor. V. K	. (2022) Fu	Indame	entals o	of Applied	
		Statistics, S	ultan Cha	ind & Sons,	New Delhi			-r r••	
		3. Pillai R.	S. N. And	Bagavathi.	V. (2005),	Statist	ics, S.	Chand &	
		Company L	.td., New	Delhi					

<b>Reference Books</b>	1. Sancheti D. C. And Kapoor. V. K (2005), Statistics (7th Edition),							
	Sultan Chand & Sons, New Delhi.							
	2. Arora P. N, Comprehensive Statistical Methods, Sultan Chand &							
	Sons, New Delhi.							
	3. Murthy M. N (1978), Sampling Theory and Methods, Statistical							
	Publishing Society, Kolkata							
Website and	1. https://www.aicte-							
e-Learning Source	india.org/flipbook/p≈/Vol.%20II%20UG/UG_2.html#p=							
	2.https://www.britannica.com/topic/operations-research							

1. Analyze the statistical data and its usage in the measures of location and dispersion

2.Understand the relationship between variables and forecasting the future values.

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

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

*S-Strong; M-Medium; L-Low

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

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					
<b>Course Contribution to</b>	3.0	3.0	3.0	3.0	3.0
Pos					

11.4.4	Statistical	<b>Tools for</b>	Analysis
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Title of the	Course	Statistical Tools for Analysis								
Paper Num	ber	IV								
Category	NME	Year Credits 2 Course								
		Semester		-		Code				
Instruction	al Hours	Lecture	Tut	orial	Lab Prac	tice	Tota	1		
per week		2	1				3			
Pre-requisit	te	Basics in St	atistics.				-			
Objectives	of the	The main of	piectives of	of this course	are to:					
Course		1. To equip s	tudents w	ith theoretica	al knowledg	ge for	testing	tools		
course		2. To learn th	e concept	s of testing o	of hypothes	is, sig	nifican	ce of large and		
		small sample	tests	C C	• 1			C		
Course Out	line	Unit I: Con	cept of Po	pulation and	l sample – '	Types	of pop	ulation –		
		Hypothesis	– Types o	f Hypothesis	– Type I a	ind Ty	pe II E	rrors –		
		Sampling dis	stribution	and Standard	Error - Lev	vel of s	signific	cance.		
		Init II. Los	a compl	Tasta Das	ad on maa	naand	Vorio			
		Proportions	ge sample	e resis - das	ed on mea	ns and	varia	nces –		
		Unit III: Sr	nall sampl	e tests - t – t	est for mean	ns – di	fferenc	e between two		
		means $-t - t$	est for cor	relation co- e	fficient.	ui ui				
		Unit IV: Ch	i – Squar	e test – test f	or single va	arianc	e – for	independence		
		of attributes	– goodne	ss of fit. AN	OVA for o	ne – v	vay and	1 two – way		
		classificatio	n.							
		Unit V: Mu	ltivariate	analysis – Fa	ictor analys	sis - D	Discrim	inant analysis -		
		Cluster anal	ysis. Struc	ctural Equation	on Models	-D1a	gram s	ymbols –		
Extended Dr	ofessional		sing ratif	allalysis (CO	licept Ollry	).				
Component	(is a part of	Questions	related to	the above	e topics, f	from	variou	s competitive		
internal com	ponent only.	examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /								
Notto be inc	luded in the	others to be	solved							
External Exa	amination	(To be discu	ussed durin	ng the Tutori	al hour)					
question pap	per)	`		0	,					
Skills acqui	ired from	Knowledge	, Proble	m Solving	Analytic	cal a	bility,	Professional		
this course		Competenc	y, Profess	ional Comm	unication a	nd Ira	ansterr	able Skill		
Recommend	ded	1. Gupta C. E	8 (1978), 4	An Introduct	ion to Stati	stical	Metho	ds, Vikas		
Text Books		Publishing H	ouse, Nev	v Delhi.	a a			0 0 1 5		
		2. Snedecor	G.W and	Cochran W.	J., Statistic	al Me	thods,	Oxford Press		
		and IBH.	(2022) -			6.01		<b>·</b>		
		3. Rex Kline	(2023), Pi	rinciples and	Practice of	f Struc	ctural E	Equation		
		Modelling,								

<b>Reference Books</b>	1. Pillai R. S. N. And Bagavathi. V. (2005), Statistics, S. Chand &						
	Company Ltd., New Delhi.						
	2. Sancheti D. C. And Kapoor. V. K (2005), Statistics (7th Edition),						
	Sultan Chand & Sons, New Delhi.						
	3. Arora P. N, Comprehensive Statistical Methods, Sultan Chand & Sons,						
	New Delhi.						
Website and e-Learning Source	https://statisticsbyjim.com/regression/curve-fitting-linear-nonlinear- regression/						
	https://www.investopedia.com/terms/c/chi-square-statistic.asp						
	http://onlinestatbook.com/2/introduction/inferential.html						

1. Analyze the statistical data by using statistical testing tools

2. Understand the concept of Multivariate analysis and.

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

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

*S-Strong; M-Medium; L-Low

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

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					
<b>Course Contribution to</b>	3.0	3.0	3.0	3.0	3.0
Pos					