KUNTHAVAI NAACCHIYAAR GOVT ARTS COLLEGE (W) AUTONOMOUS, THANJAVUR – 7

(Affiliated to Bharathidasan University)

M.Sc., Statistics

SYLLABI

2023-2024 *Onwards*

(APPROVED BY BOARD OF STUDIES)

M.SC., STATISTICS

SYLLABUS

FROM THE ACADEMIC YEAR 2023-2024

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

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   05/07/23

CONTROLLER OF EXAMINATIONS
25 AUG 2023
Govt. Arts College for Women (Autonomous) Thanjavur

BOD OF STATISTICS
A.N.G.A.C. (W) (AUTO)
THANJAVUR

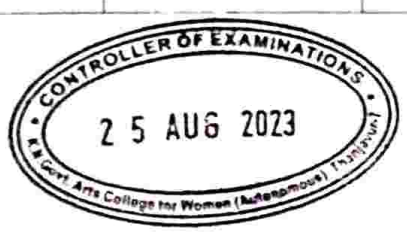
KUNTHAVAI NAACHIYAAR GOVT. ARTS COLLEGE FOR WOMEN (AUTONOMOUS) THANJAVUR

PG Programmes - Course Structure under CBCS

M. Sc., STATISTICS

(applicable to the candidates admitted from the academic year 2023-2024 onwards)

Semester	Part	Course	Sub. Code	Title of the Course	Inst.Hrs	Credits	Exam Hrs	IA	EE	Total
I	A	CC1	23KP1S01	1.1 Real Analysis & Linear Algebra	7	5	3	25	75	100
		CC2	23KP1S02	1.2 Sampling Methods	7	5	3	25	75	100
		CC 3	23KP1S03	1.3 Distribution Theory	6	4	3	25	75	100
		EC1	23KP1SECS1:1	1.4 Categorical Data Analysis	5	3	3	25	75	100
			23KP1SECS1:2	Population Studies						
		EC2	23KP1SECS2:1	1.5 Bayesian Inference	5	3	3	25	75	100
			23KP1SECS2:2	Clinical Trials						
				Total	**30**	**20**				**500**
II	A	CC4	23KP2S04	2.1 Estimation Theory	6	5	3	25	75	100
		CC5	23KP2S05	2.2 Measure and Probability Theory	6	5	3	25	75	100
		CC6	23KP2S06	2.3 Time Series Analysis	6	4	3	25	75	100
		EC3	23KP2SECS3:1	2.4 Actuarial Statistics	4	3	3	25	75	100
			23KP2SECS3:2	Simulation Analysis						
		EC4	23KP2SECS4:1	2.5 Survival Analysis	4	3	3	25	75	100
			23KP2SECS4:2	Econometrics						
	B	SEC1	23KP2SSEC1P	2.6 Practical-I (CC IV&VI Based on R Programming)	4	2	3	40	60	100
	C	EC1	23KP2SECC1:1	Statistics For Life Sciences		3*	3	-	100	100
			23KP2SECC1:2	2.7 MOOC (Value Added)						
		EC2	23KP2SECC2	Introduction to Python (Add on Course)	-	4*	-	-	-	-
				Total	**30**	**22**				**600**



III	A	CC7	23KP3S07	3.1 Testing of Statistical Hypothesis	6	5	3	25	75	100
		CC8	23KP3S08	3.2 Linear Model	6	5	3	25	75	100
		CC9	23KP3S09	3.3 Multivariate Analysis	6	5	3	25	75	100
		CC10	23KP3S10	3.4 Design of Experiments	6	4	3	25	75	100
		EC5	23KP3SECS5:1	3.5 Operation Research	3	3	3	25	75	100
			23KP3SECS5:2	Database Management System						
		SEC2	23KP3SSEC2	3.6 Practical – II (Core Course VII,VIII &IX)	3	2	3	40	60	100
		ECC1	23KP3I	3.7 Internship / Industrial Activity		2				
	C	EC3	23KP3SECC3:1	3.8 Optimization Techniques		3*	3	-	100	100
			23KP3SECC3:2	MOOC (Value Added)						
				Total	**30**	**26**				**600**
IV	A	CC11	23KP4S11	4.1 Stochastic Process	6	5	3	25	75	100
		CC12	23KP4S12	4.2 Machine Learning Techniques	6	5	3	25	75	100
		CC13	23KP4SPW	4.3 Project with viva voce	10	7			100	100
		EC6	23KP4SECS6:1	4.4 Non-Parametric Inference	4	3	3	25	75	100
			23KP4SECS6:2	Reliability Theory						
	B	SEC3	23KP4SSEC3	4.5 Professional Competency Skill Enhancement Course Training for Competitive Examinations • Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours) • General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours) OR Statistics for Advanced Research Studies (4 hours)	4	2	3	25	75	100
	C		23KP4EA	4.6 Extension Activity		1				
				Total	**30**	**23**				**500**
				GRAND TOTAL	**120**	**91**				**2200**

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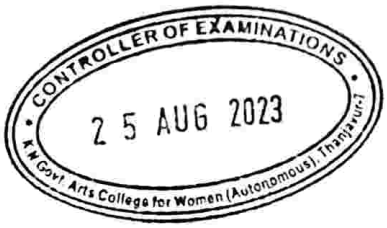
A.V.V.M. Govt. Arts College for Women (Autonomous)

6 CURRICULUM DESIGN

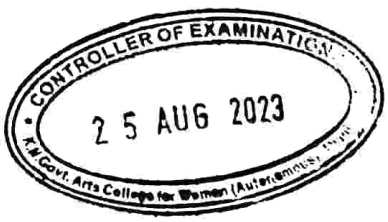
Semester–I	C	H	Semester-II	C	H	Semester-III	C	H	Semester–IV	C	H
1.1.Core–I	5	7	2.1.Core-IV	5	6	3.1.Core-VII	5	6	4.1.Core-XI	5	6
1.2Core–II	5	7	2.2Core-V	5	6	3.2Core-VIII	5	6	4.2Core-XII	5	6
1.3Core–III	4	6	2.3Core-VI	4	6	3.3Core-IX	5	6	4.3 Projectwith Viva-Voce	7	10
1.4 Elective–I	3	5	2.4 Elective-III	3	4	3.4 Core – X (IndustryModule)	3	4	-		
1.5 Elective–II	3	5	2.5 Elective-IV	3	4	3.5 Elective-V	3	4	4.4 Elective-VI	3	4
			2.6 Skill Enhancement Course SEC-II Practical – II (Core IV&VI Based on R Programming)	2	4	3.6 Skill Enhancement Course SEC-III Practical-II(Core VII&VIIIBased on Python Programming)	2	2	4.5 Skill EnhancementCourse SEC-IV Practical - III(Core XI & XII Basedon Python)	2	4
						3.7Internship/ IndustrialActivity		-	4.6 ExtensionActivity	1	-
	20	30		22	30		22	30		23	30

C-Credit H -Hours — Total Credit Points 91



TNSCTE

CONTENTS

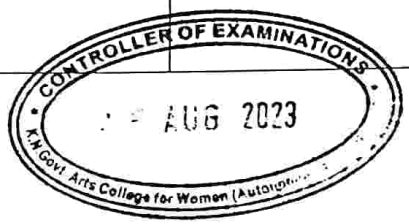


1. **Cognitive Domain**
   (Lower levels: K1: Remembering ; K2: Understanding ; K3: Applying;
   Higher levels: K4: Analysing ; K5: Evaluating; K6: Creating)
2. **Affective Domain**
3. **Psychomotor Domain**

2. Structure of Course

Course Code	**Course Name**		**Credits**
Lecture Hours: (L) per week	**Tutorial Hours : (T) per week**	**Lab Practice Hours: (P)per week**	**Total: (L+T+P) per week**
Course Category :	**Year & Semester:**	**Admission Year:**	
Pre-requisite			
Links to other Courses			
Learning Objectives: (for teachers: what they have to do in the class/lab/field)			
Course Outcomes: (for students: To know what they are going to learn) **CO1:** **CO2:** **CO3:** **CO4:** **CO5:**			
Recap: (not for examination) Motivation/previous lecture/ relevant portions required for the course) [This is done during 2 Tutorial hours)			

Units	**Contents**	**Required Hours**
I		17
II		17
III		17
IV		17
V		17
Extended Professional Component (is a part of internal component only, Not to	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)	



be included in the External Examination question paper)		
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	
Learning Resources: • **Recommended Texts** • **Reference Books** • **Web resources**		
Board of Studies Date:		

3. Learning and Teaching Activities

3.1 Topic wise Delivery method

HourCount	Topic	Unit	Mode of Delivery

3.2 WorkLoad

The information blow is provided as a guide to assist students in engaging appropriately with the course requirements.

Activity	Quantity	Workloadperiods
Lectures	60	60
Tutorials	15	15
Assignments	5	5
CycleTestorsimilar	2	4
ModelTestorsimilar	1	3
UniversityExam	1	3
	Total	90periods

4. TutorialActivities

Tutorial Count	Topic

5. LaboratoryActivities

6. Field Study Activities

7. Assessment Activities

7.1 Assessment Principles:

Assessment for this course is based on the following principles

1. Assessment must encourage and reinforce learning.
2. Assessment must measure achievement of the stated learning objectives.
3. Assessment must enablrobustand fair judgment saboutstudent performance.
4. Assessment practice must be fair and equitable to students and give them the opportunity to demonstrate what they learned.
5. Assessment must maintain academic standards.

7.2 AssessmentDetails:

AssessmentItem	DistributedDueDate	Weightage	Cumulative Weightage
Assignment1	3rdweek	2%	2%
Assignment2	6thWeek	2%	4%
CycleTest–I	7thWeek	6%	10%
Assignment3	8thWeek	2%	12%
Assignment4	11thWeek	2%	14%
CycleTest–II	12thWeek	6%	20%
Assignment5	14thWeek	2%	22%
ModelExam	15thWeek	13%	35%
Attendance	All weeks as per the Academic Calendar	5%	40%
UniversityExam	17thWeek	60%	100%

CONTROLLER OF EXAMINATIONS
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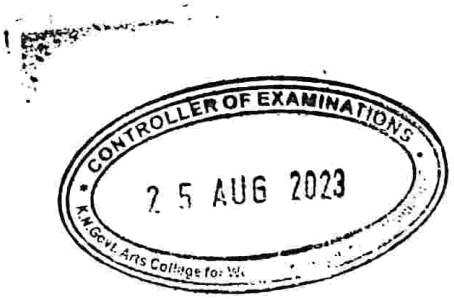
CONTENTS

a. Academic Schedule
b. Students Name List
c. Time Table
d. Syllabus
e. Lesson Plan
f. Staff Workload
g. Course Design (content, Course Outcomes(COs),Delivery method, mapping of Cos with Programme Outcomes (POs), Assessment Pattern in terms of Revised Bloom's Taxonomy)
h. Sample CO Assessment Tools.
i. Faculty Course Assessment Report(FCAR)
j. Course Evaluation Sheet
k. Teaching Materials (PPT, OHP etc)
l. Lecture Notes
m. Home Assignment Questions
n. Tutorial Sheets
o. Remedial Class Record, if any.
p. Projects related to the Course
q. Laboratory Experiments related to the Courses
r. Internal Question Paper
s. External Question Paper
t. Sample Home Assignment Answer Sheets
u. Three best, three middle level and three average Answer sheets
v. Result Analysis (CO wise and whole class)
w. Question Bank for Higher studies Preparation (GATE/Placement)
x. List of mentees and their academic achievements

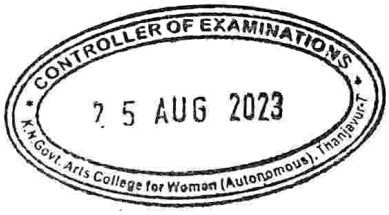


Programme Outcomes (PO) and Programme specific outcome(PSO)

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

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

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, and 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 researches that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.



8. Template for PG Programme

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	5	7	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	5	7	2.2 Core-V	5	6	3.2 Core-VIII	5	6	4.2 Core-XII	5	6
1.3 Core – III	4	6	2.3 Core – VI	4	6	3.3 Core – IX	5	6	4.3 Project with viva voce	7	10
1.4 Discipline Centric Elective -I	3	5	2.4 Discipline Centric Elective – III	3	4	3.4 Core – X	4	6	4.4Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
1.5 Generic Elective-II:	3	5	2.5 Generic Elective -IV:	3	4	3.5 Discipline Centric Elective - V	3	3	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.6 NME I	2	4	3.6 NME II	2	3	4.6 Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System for all Post – Graduate Courses including Lab Hours

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	5	7
	Core – II	5	7
	Core – III	4	6
	Elective – I	3	5
	Elective – II	3	5
		20	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	5	6
	Core – V	5	6
	Core – VI	4	6
	Elective – III	3	4
	Elective – IV	3	4
	Skill Enhancement Course [SEC] - I	2	4
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core – VII	5	6
	Core – VIII	5	6
	Core – IX	5	6
	Core (Industry Module) – X	4	6
	Elective – V	3	3
	Skill Enhancement Course - II	2	3
	Internship / Industrial Activity [Credits]	2	-
		26	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XI	5	6
	Core – XII	5	6
	Project with VIVA VOCE	7	10
	Elective – VI (Industry Entrepreneurship)	3	4
	Skill Enhancement Course – III / Professional Competency Skill	2	4
	Extension Activity	1	-
		23	**30**

Total 91 Credits for PG Courses

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K.N. Govt. Arts College for Women (Autonomous)

Credit Distribution for PG Programmein Statistics

M.Sc., STATISTICS

Illustration–I

	FirstYear Semester-I	Credit	Hours per week(L/T/P)
	CC1-RealAnalysis & Linear Algebra	5	7 (6L+ 1T)
	CC2-Sampling Methods	5	7 (6L+ 1T)
	CC3 -Distribution Theory	4	6 (5L+ 1T)
	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)
	Total	**20**	**30**

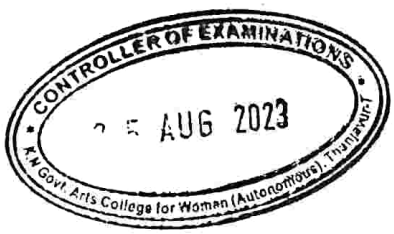
	Semester-II	Credit	Hours per week(L/T/P)
	CC4–Estimation Theory	5	6 (5L+ 1T)
	CC5–Measure and Probability Theory	5	6 (5L+ 1T)
	CC6-Time Series Analysis	5	6 (5L+ 1T)
	ElectiveIII(Generic/DisciplineSpecific)(OnefromGroupC)	3	4 (3L+ 1T)
	Elective-IV(Computer /IT related)(One from Group D)	3	4 (3L+ 1T)
	Skill Enhancement Course-SEC2, Practical–II (Core IV &VI Based on R Programming) NME	2	2
	Total	**22**	**30**

Internship during Summer Vacation. The Credits shall be awarded in Semester–III
Statement of Marks

	SecondYear - Semester-III	Credit	Hours per week(L/T/P)
	CC7- Testing of Statistical Hypothesis	5	6 (5L+ 1T)
	CC8 –Linear Models	5	6 (5L+ 1T)
	CC9 – Multivariate Analysis	5	6 (5L+ 1T)
	CC10– Design of Experiments	4	6
	Elective V(Generic/Discipline Specific)(One from Group E)	3	3
	Skill Enhancement Course-SEC3: Practical–III(Core VII, VIII&IX Based on Python) NME	2	3
	Internship/IndustrialActivity (Carried out in Summer Vacation at the end of I year– 30hours)	2	-
	Total	**26**	**30**

	Semester-IV	Credit	Hours per week(L/T/P)
	CC11-Stochastic Process	5	6 (5L+ 1T)
	CC12- Machine Learning Techniques	5	6 (5L+ 1T)
	Project with viva voce	7	10
	Elective VI (Generic/Discipline Specific)(One from Group F)	3	4 (3L+ 1T)
	Professional Competency Skill Enhancement Course Training for Competitive Examinations • Mathematics for NET/UGC-CSIR/SET/TRB Competitive Examinations (2hours) • General Studies for UPSC/TNPSC/Other Competitive Examinations (2hours) OR Statistics for Advanced Research Studies(2hours)	2	4
	Extension Activity	1	
	Total	**23**	**30**

TOTALCREDITS:91



Consolidated Table for Credits Distribution

	Category of Courses	Credits for each Course	Number of Courses	Number of Credits in each Category of Courses	Total Credits	Total Credits for the Programme
	Core	4	12	48	72	80(CGPA)
	Project with vivavoce	3	1	3		
	Industry Aligned Programmes-	3	1	3		
	Elective (Generic and Discipline Centric)	3	6	18		
(i)	Skill Enhancement (Term paper and Seminar &Generic/ Discipline - Centric Skill Courses) (Internal Assessment Only)	2	4	8	8	
(ii)	Ability Enhancement (Soft skill)	2	4	8	10	11(Non CGPA)
(iii)	Summer Internship	1	2	2		
	Extension Activity	1	1	1	1	
						91

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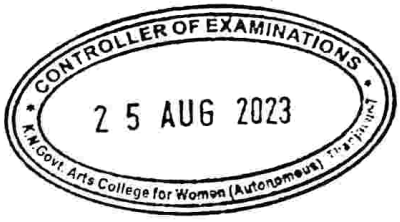
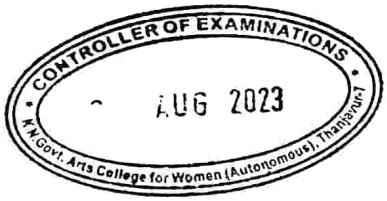
H.N.Govt. Arts College for Women (Autonomous), Thanjavur-1

9. Template for Semester

Code	Category	Title of thePaper	Marks (Max100)		Duration for UE	Credits
			CIA	UE		
Semester–I						
PartA	CoreI		25	75	3Hrs	4
	CoreII		25	75	3Hrs	4
	CoreIII		25	75	3Hrs	4
	ElectiveI	Elective-I (Choose one from Group-A)	25	75	3Hrs	3
	ElectiveII	Elective-II (Choose one from Group-B)	25	75	3Hrs	3
PartB	Skill Enhancement Course-SEC1	Practical–I (Core II&III Based on R Programming)	25	75	3 Hrs	2
	Ability Enhancement Course (AECC1)	Soft Skill I	Performance based assessment			2
Semester-II						
PartA	CoreIV		25	75	3Hrs	4
	CoreV		25	75	3Hrs	4
	CoreVI		25	75	3Hrs	4
	ElectiveIII	Elective-III (Choose one from Group-C)	25	75	3Hrs	3
	ElectiveIV	Elective-IV(Choose one from Group-D)	25	75	3Hrs	3
PartB	Skill Enhancement Course-SEC2	Practical–II(Core IV &VI Based on R Programming)	25	75	3 Hrs	2
	Ability Enhancement Course (AECC2)	Soft Skill II	Performance based assessment			2



Semester-III						
PartA	Core VII		25	75	3Hrs	4
	Core VIII		25	75	3Hrs	4
	CoreIX		25	75	3Hrs	4
	Elective/EDV	Elective-VI /ED-V (Choose one from Group-E)	25	75	3Hrs	3
	Core IndustryModule	ED-IV (Choose from outside the Department) Statistical Quality Control	25	75	3Hrs	3
PartB						
	Skill based (Term paper and Seminar)	Practical–III (Core VII, VIII & IX Based on Python)	25	75	3 Hrs	2
	Ability Enhancement Course (AECC3)	Soft Skill III	Performance based assessment			2
	Internship/Industrial- VacationActivity					2
Semester-IV						
	CoreX		25	75	3Hrs	4
	CoreXI		25	75	3Hrs	4
	Core XII		25	75	3Hrs	4
	Project with viva voce XIII		25	75	3Hrs	3
	ElectiveVI	Elective-VI (Choose one from Group–F)	25	75	3Hrs	3
	Skill Enhancement Course-SEC4	Professional Competency Skill Enhancement Course	Internal Assessment			2
	AbilityEnhancement Course(AECC4)	SoftSkillIV	Performance based assessment			2
	Extension Activity	Performance based assessment				1
					TotalCredits	**91**



ElectiveCourses

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

Semester I: Elective I and Elective II

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

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

1. Categorical Data Analysis
2. Population Studies

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

1. Bayesian Inference
2. Clinical Trials

Semester II: Elective III & Elective IV

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

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

1. Actuarial Statistics
2. Simulation Analysis

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

1. SurvivalAnalysis
2. Econometrics

Semester III: Elective V

Elective V to be chosen from Group E.

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

1. Operations Research
2. Database Management System

Semester IV: Elective VI

Elective VI to be chosen from Group F.

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

1. Non-parametricInference
2. Reliability Theory

Skill Enhancement Courses

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

Group G (Skill Enhancement Courses) SEC:

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

Ability Enhancement Courses

- Soft Skill courses

Extra Disciplinary Courses for other Departments not for Statistics students)

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

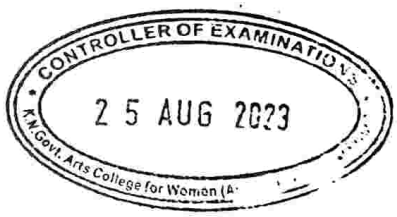
ED-I: Statistics for Life Sciences

ED-II: Statistics for Social Sciences

ED-III: Financial Mathematics

ED-IV: Optimization Techniques

ED-V: History of Statistics



Instructions for Course Transaction

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

Testing Pattern (25+75)

Internal Assessment

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

Computer Laboratory Courses: For Computer Laboratory oriented Courses, there shall be twotests in Theory part and two tests in Laboratory part. Choose one best from Theory part and otherbest from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 25 marks. The duration of each test shall be one/one and a half hour.

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

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14. Different Types of Courses

(i) Core Courses (Illustrative)

1. Real Analysis and Linear Algebra
2. Sampling Methods
3. Distribution Theory
4. Estimation Theory
5. Measure and Probability Theory
6. Time Series Analysis
7. Testing of Statistical Hypotheses
8. Linear Models
9. Multivariate Analysis
10. Design of Experiments
11. Stochastic Process

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

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

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

(iv) Skill Development Courses

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

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

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SYLLABUS

Syllabus for Core Courses

Real Analysis and Liner Algebra

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Real Analysis and Liner Algebra</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">CC</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23KP1S01</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours Per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">LabPractice</td><td>Total</td></tr>
<tr><td>6</td><td colspan="2">1</td><td colspan="2">-</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Under graduate level Vector Algebra and Matrix Theory</td></tr>
<tr><td colspan="2">Objectives of theCourse</td><td colspan="6">1. To provide recollection as well as building Mathematical foundation in Real Analysis and Matrix Theory
2. To understand concepts and definition of metrics pace and theorems related to it
3. To know integration and differentiation concepts and its application, to know real functions in one variable as well as several variables, understand it on numerical problems</td></tr>
<tr><td colspan="2" rowspan="4">CourseOutline</td><td colspan="6">UNIT I: Metric Space–open,closed sets – Intervals (rectangles), Real valued Continuous functions- Discontinuities - compact sets, Bolzano– Weirstrass theorem, Heine –Borel theorem.</td></tr>
<tr><td colspan="6">UNIT II: Derivatives - maxima and minima - Riemann integral &Riemann – Stieltjes integral with respect an increasing integrator – properties of R.S. integral. Functions of several variables, constrained and un constrained maxima – minima of functions.</td></tr>
<tr><td colspan="6">UNIT III: Basic properties of matrices (orthogonal, idempotent, Kronecker product, projection operators etc); Linear dependence,independenceandrankofamatrix;characteristicrootsandpolynomial,
Multiplicity of characteristic roots; Cayley Hamilton theorem; inverse of a matrix and determinants;</td></tr>
<tr><td colspan="6">UNIT IV: Reduction of matrices, Echelon form, Hermite canonical form, diagonal reduction, rank factorization, triangular reduction Jordan form; Symmetric matrices and its properties; Decomposition like, singular valued composition, spectral decomposition, Cholesky decomposition etc.</td></tr>
</table>

	UNIT V: Matrix differentiation; Generalized inverse and its properties, Moore- Penrose inverse; Application of g-inverse; Quadratic forms, classification, definiteness, index and signature, extremum; transformation and reduction of quadratic form; applications of Quadraticforms.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination Question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge,ProblemSolving,Analyticalability,Professional Competency,ProfessionalCommunicationandTransferrableSkill

Recommended TextBooks	1.Rudin, Walter (1976):Principles of Mathematical 2. Analysis,Mc Graw Hill. Apostol, T.M.(1985): Mathematical Analysis, Narosa,IndianEd. 3.Graybill,F.A.(1983):Matrices with application in Statistics, 2nded. Wadsworth. 4.Rao,C.R.&Bhimasankaran,P.(1992):Linearalgebra,TataMcGraw Hill Pub.Co.Ltd. 5.Searle, S.R. (1982) : Matrix Algebra useful for Statistics, JohnWileyandSons,Inc.
ReferenceBooks	1.Royden, H.L.(1995) : Real analysis, 3ed., Prentice Hall of India.2.Rangachari,M.S.(1996):RealAnalysis,Part1,NewCenturyBook House.Ash, 3.R.B. (1972): Real analysis and probability, Academic press.4.Biswas,S.(1984):TopicsinAlgebraofMatrices,AcademicPublications. 5.David, A.Harville(1997) : Matrix algebra from a statistician'sperspective, Springer. Hoffman, K. and Kunze, R. (1971) :LinearAlgebra, 2nded.Prentice Hall,Inc.
Websiteand e-LearningSource	e-books,tutorialsonMOOC/SWAYAMcoursesonthesubject

CourseLearningOutcome(forMappingwithPOsand PSOs)

Studentswill beableto

1. GetaMathematicalfoundationinRealanalysisandMatrixTheorytounderstandunivariateandmultivariate concepts in Statistical Theory
2. GetaclearunderstandingR.S.integral,partialdifferentiationinseveralvariablefunctions, gettheoreticalknowledgebyunderstandingtheneed andapplicationoftheoremslikeBolzano–
3. Weirstrasstheorem,Heine– Boreltheorem
4. Understandconceptsinmatrixtheory-rankandfactorization,inverseofmatrix,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 Abletogetsolvenumericalproblemsandevaluateandinterpretoutcome

6 Analyzereal lifeproblemsandexploreresearchproblems

CO-POMapping(CourseArticulationMatrix)

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

S-Strong,M-Medium,W-Weak

Level of Correlation betweenPSO's andCO's

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

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Sampling Methods

Title of the Course		**Sampling Methods**					
Paper Number		**II**					
Category	**CC**	**Year**	**I**	**Credits**	**5**	**Course Code**	**23KP1S02**
		Semester	**I**				
Instructional Hours Per week		**Lecture**	**Tutorial**	**LabPractice**	**Total**		
		6	1	-	7		
Pre-requisite		Undergraduate level Sampling Techniques					
Objectives of the Course		1. To cover sampling design and analysis methods 2. To explain and compare various sampling procedures. 3. To understand the concepts of bias and sampling variability and strategies for reducing the bias and sampling variability.					
CourseOutline		**UNIT I:** Preliminaries–Simple Random Sampling–Stratified sampling, allocation problems and systematic sampling.					
		UNIT II: PPS selection methods- PPSWR and PPSWOR sampling methods–Sen-Midzuno sampling method–Ordered and Unordered Estimators.					
		UNIT III: Cluster Sampling-Equal cluster sampling–Estimators of mean and variance, optimum cluster size, Unequal cluster sampling – Estimators of mean and variance.					
		UNIT IV: Ratio Estimation–Unbiased Ratio Type estimators–Regression Estimation-Double Sampling for Ratio and Regression Estimation					
		UNIT V: Multistage Sampling-Randomized Response Methods–Call Back Techniques					
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /applied survey techniques adopted in Economics and Statisticsdepartmentof Tamil Nadu StateGovernment. (TobediscussedduringtheTutorialhour)					
Skillsacquiredfrom thiscourse		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					
Recommended TextBooks		1. S.Sampath(2005): Sampling Theory and Methods, Narosha Publishing House. 2. W.G.Cochran(1965):Sampling Techniques,Wiley andSons 3. Desraj(1976):Sampling Theory, Mc Graw Hill, NewYork.					

Reference Books	1. M.N.Murthy(1967) : Sampling Theory and Methods:Statistical Publishing Society, Calcutta Parimal Mukhopadhyay (2005) : Theory and Methods of Survey Sampling, Prentice Hall of India 2. 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-LearningSource	e-books, online tutorials taken from MOOC/SWAYAM plat form fo rthis subject.

Course Learning Outcome (for Mapping with Pos and PSOs)

Students will be able to

7. To apply basics and advanced levels of sampling methods for different types of data.
8. To draw a conclusion about the best sampling procedure.
9. To use practical applications of ratio and regression method of estimations.
10. To analyze data from multi-stage sampling methods.
11. 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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	M	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong,M-Medium,W-Weak

Level of Correlation between PSO's and CO's

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

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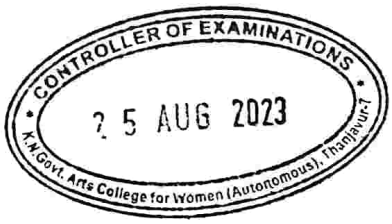
DistributionTheory

Title of the Course		Distribution Theory					
Paper Number		III					
Category	CC	Year	I	Credits	4	Course Code	23KP1S03
		Semester	I				
Instructional Hours Per week		Lecture		Tutorial		LabPractice	Total
		5		1		-	6
Pre-requisite		Undergraduate level Distribution Theory.					
Objectives of the Course		1. To provide the practical knowledge on the concept of functions of random variables and its usage. 2. To educate the knowledge on the both discrete and continuous distributions. 3. To acquire the knowledge on deriving its characteristics of distributions.					
CourseOutline		**UNIT I:** Brief review of distribution theory, functions of random variables and their distributions using Jacobian of transformation, Laplace and Cauchy distribution, lognormal distribution, gamma, logarithmic series.					
		UNIT II: Bivariate Normal Distribution –Compound and truncated Distributions of Binomial, Poisson and Normal distributions.					
		UNIT III: Sampling distributions, non-central chi-square distribution, t and F distributions and their properties, distributions of quadratic form s under normality and related distribution theory– Cochran's and James theory.					
		UNIT IV: Order statistics their distributions and properties, Joint and marginal distributions of order statistics, extreme value and their asymptotic distributions, approximating distributions of sample moment, delta method.					
		UNIT V: Kolmogorov Smirnov distributions, life distributions, exponential, Weibull and extreme value distributions Mills ratio,distributionsclassified byhazardrate.					



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,f rom various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /otherstobesolved (TobediscussedduringtheTutorialhour)
Skills acquired from This course	Knowledge, Problem Solving, Analytical ability, Professional Competency,ProfessionalCommunicationandTransferrableSkill
Recommended Text Books	1. Gibbons(1971):Non-parametricinference,TataMcGrawHill. 2. Rohatgi,V.K.andMd.WhsanesSaleh,A.K.(2002):Anintro ductiontoprobability&Statistics,JohnWileyand Sons.
Reference Books	1. Rao,C.R.(1973): Linear statistical inference and its applications,2ed,WileyEastern. 2. Mood,A.M. &Graybill, F.A. and Boes, D.C. :Introduction to the theory of statistics, McGraw Hill.Johnson,S. &Kotz,(1972): Distributions in Statistics,Vol.I,II& III,Hougton&Miffin. 3. Dudewicz, E.J., Mishra, S.N.(1988) : Modern mathematical statistics, John Wiley. Searle, S.R.(1971) : Linear models, JohnWiley. 4. Primal Mukopadhyay (2006) Mathematical Statistics, 3rd edition,New Central Book Agency
Websiteand e-LearningSource	e-books, onlinetutorialstakenfrom MOOC/SWAYAMplatformforthissubject.

Course Learning Outcome(for Mapping with Pos and PSOs)

Students will be able to

1 Tounderstandtheknowledgeonimportanceoftherandomvariablesanditsroleinthedistributiontheory.
2 Tointerprettheproperiesofspecialunivariatecontinuousdistributions,truncatednormaldistributi onand few non-central distributions.
3 Toexplainthemomentsforthedatacomefromtheunivariateandbivariatedistributions.
4 Tointerpretthedistributionsoforderstatisticswithregardto Median,SampleRangeandJointdistributi onoforder two.
5 Toidentifythedatadistributionbasedononesampleandtwosamplesusing KStests.

CO-POMapping(CourseArticulationMatrix)

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

S-Strong,M-Medium,W-Weak

Level of Correlation between PSO'sand 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
Weightedpercentageof Course ContributiontoPos	3.0	3.0	3.0	3.0	3.0

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ElectiveCourses

SemesterI: Elective I and Elective II

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

GroupA:

Categorical Data Analysis

Title of the Course	**Categorical Data Analysis**					
Paper Number	**I**					
Category **MBE**	**Year**	I	**Credits**	3	**Course Code**	23KP1SECS1:1
	Semester	I				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	1	-	5		
Pre-requisite	Undergraduate Level Statistical Models.					
Objectives of the Course	1. The aim of this course is to demonstrate students both theoretical rationale and important applications of categorical data analysis methods. 2. Provide students with skills to either conduct their own research using categorical data analysis or to be able to replicate existingresearch usingthesemethods.					
Course Outline	**UNIT I:** Models for Binary Response Variables, Log Linear Models,Fitting Log linear and Logic Models-Building and applying Log Linear Models ,Log-Linear-Log it Models for Ordinal Variables.					
	UNIT II: Multinomial Response Models-Models for Matched Pairs-Analyzing Repeated Categorical Response Data-Asymptotic Theory for Parametric Models- Estimation Theory for Parametric Models.					
	UNIT III: Introduction to contingency tables: 2 × 2 and r × c tables – measures of association and nonparametric methods. Tests for independence and homogeneity of proportions - Fishers exact test – Odds ratio and Logit,othermeasuresofassociation-Introductionto3-waytables –full independence and conditional independence-collapsing and Simpsons paradox.					
	UNIT IV: Generalized linear models - Logistic regression for binary - multinomial and ordinal data - Log-linear models - Poisson regression-Modelingrepeatedmeasurements-generalizedestimatingequations.					
	UNIT V: Polychromous logit models for ordinal and nominal response - Log-linearmodels(andgraphicalmodels)formulti-waytables-Causality,repeated measures, generalized least squares - mixed models, latent-classmodels,missingdata.					

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from This course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1.Agresti,Alan.(1996)AnIntroductiontoCategoricalDataAnalysis ,Wiley,New York.
Reference Books	1. Bergsma, W. Croon, M.A. and Hagenaars, J.A. (2009) MarginalModels:ForDependent,Clustered,andLongitudinalCategoricalData.Springer, New York. 2. Bishop, Y.M. Fienberg, S.E. and Holland, P.W. (1975) DiscreteMultivariateAnalysis:TheoryandPractice,MITPress,Cambridge. 3. Edwards,D.(2000).IntroductiontoGraphicalModeling,2/e,Springer, New York. 4. Fienberg, S.E. (1980). The Analysis of Cross-ClassifiedCategoricalData. MITPress, Cambridge. 5. Wasserman, L.(2004)All ofStatistics:A ConciseCourseinStatisticalInference. Springer,New York.
Websiteand e-Learning Source	e-books, onlinetutorialstakenfrom MOOC/SWAYAM plat form for this subject.

Course Learning Outcome(for Mapping with Pos and PSOs)

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 analysismethods.
2. Thestudent willbe able toderiveandworkwith samplingdistributionsof binaryorcategoricalmeasures.
3. Studentswillbefamiliarwithavarietyofmethodsforanalyzingcategoricalorcountdata.

CO-POMapping(CourseArticulationMatrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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23kp1SEcS1:2

Population Studies

Title of the Course		**Population Studies**						
Paper Number		**I**						
Category	**MBE**	**Year**	I	**Credits**	3	**Course Code**	23KP1SEcS1:2	23KP1SEcS1:2
		Semester	I					
Instructional Hours Per week		**Lecture**		**Tutorial**		**LabPractice**		**Total**
		4		1		-		5
Pre-requisite		Undergraduate level Demography.						
Objectives of the Course		1. This course aims to provide students with basic knowledge of statistical techniques which can be used in demographic analysis. 2. The course will also help in studying Population growth and population projection.						
Course Outline		**UNIT I:** Simple Registration System, SRB Bulletin, Coverage and content errors in demographic data, Chandrasekharan-Deming formulato check completeness of registration data, adjustment of age data- use of Whipple ,Myer and UN indices. population transition theory.						
		UNIT II: Measures of fertility; stochastic models for reproduction,distributionsoftimeofbirth,inter-livebirthintervalsandofnumberofbirths (for both homogeneous and homogeneous groups of women),estimation of parameters; estimation of parity progression from openbirthinterval data.						
		UNITIII: MeasuresofMortality;constructionofabridgedlifetables,infant mortalityrate and itsadjustments, model lifetable.						
		UNIT IV: Stable and quasi-stable populations, intrinsic growth rate. Models of population growth and their filling to population data. Internal migration and its measurement, migration models, concept to international migration.						
		UNIT V: Methods for population projection, component method of population projection, Nuptiality and its measurements.						
Extended Professional Component(is a part of internal Component only, Not to be included in the External Examination questionpaper)		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)						

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Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Kumar, R. (1986): Technical Demography, WileyEasternLtd. 2. Benjamin, B.(1969):DemographicAnalysis,George,AllenandUnwin.
Reference Books	1. Cox,P.R.(1970):Demography, Cambridge University Press. 2. Keyfitz,N.(1977):Introduction to the Mathematics of Population- with Revisions, Addison-Wesley, London. 3. Spiegelman,M.(1969):Introduction to Demographic Analysis, Harvard University Press. 4. Wolfenden,H.H.(1954):Population Statistics and Their Compilation, Am Actuarial Society.
Website and e-Learning Source	e-books, onlinetutorialstakenfrom MOOC/SWAYAM plat form for this subject.

Course Learning Outcome (for Mapping with Pos and PSOs)

Students will be able to

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

CO-PO Mapping(Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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GroupB:
Bayesian Inference

Title of the Course		**BayesianInference**					
Paper Number		**II**					
Category	**MBE**	**Year**	I	**Credits**	3	**Course Code**	23KP1SECS2:1
		Semester	I				
Instructional Hours perweek		**Lecture**		**Tutorial**	**LabPractice**	**Total**	
		4		1	-	5	
Pre-requisite		Probability models, parametric and non-parametric inference.					
Objectives of the Course		1. Estimation using pre-knowledge about the parameters. 2. To learn and develop scientific view to study the statistical challenges of clinical comparison of two or more treatment					
Course Outline		**UNIT1:** Statistical decision theory – loss functions – 0-1, absolute error, squared error and LINEX loss functions–risk function– mini max solution – prior distribution – Bayes risk – Bayes solution todecisionproblems.					
		UNIT II: Subjective probability – its interpretation and evaluation - Subjective determination of prior distributions - Improper prior, non-informative prior,invariantprior,Jeffrey'snoninformativepriorand natural conjugate prior– family of distributions admitting naturalconjugateprior.					
		UNIT III: Point estimation – Bayes estimators under various lossfunctions – generalization to convex loss functions - Evaluation of theestimateintermsofposteriorrisk–comparisonwithfrequentistmethods.					
		UNIT IV: Interval estimation – credible interval, highest posteriordensity region - Comparison of interpretation of the confidence co-efficient of an interval by Bayesian and frequentist methods – simple problems.					
		UNIT V: Bayesian testing of statistical hypotheses – specification ofthe appropriate form of the prior distribution for Bayesian hypothesistesting problem – prior odds, posterior odds, Bayes factor and their computations to various hypotheses testing problems–specification of Bayes tests.					
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 (TobediscussedduringtheTutorialhour)					

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability,Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Bansal,A.K.(2007) Bayesian Parametric Inference, Narosa, New Delhi. 2. Berger,J.O.(1985) Statistical Decision Theory and Bayesian Analysis ,2/e, Springer, New York.
Reference Books	1. Bernardo,J.M.andSmith,A.F.M.(2000) Bayesian Theory, Wiley, New York. 2. Gelman,A.Carlin,J.B.Stern,H.B.andRubin,D.B.(2013) Bayesian Data Analysis,3/e,CRC press,London 3. Ghosh, J.K. Delampady, M. and Samanta, T. (2010) An Introduction to Bayesian Analysis: Theory and Methods ,Springer, New York. 4. Lee, P.M. (2012) Bayesian Statistics – An Introduction, 4/e,Wiley,London. 5. Leonard, T. and J.S.J. Hsu. (1999) Bayesian Methods: An Analysis for Statisticians and Inter disciplinary Researchers, Cambridge University Press,London.
Websiteand e-Learning Source	e-books, onlinetutorialstakenfromMOOC/SWAYAM plat form for this subject.

Course Learning Outcome (for Mapping with Pos and PSOs)

Students will be able to

1. Explain in detail the Bayesian frame work 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. ShowhighlevelInterpretationofBayesianAnalysisResultsandbeabletoreadilyperform Bayesian model evaluation and assessment

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO'sandCO'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
WeightedpercentageofCourseContributionto Pos	3.0	3.0	3.0	3.0	3.0

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Clinical Trials

Titleof the Course		**Clinical Trials**					
Paper Number		**II**					
Category	**MBE**	**Year**	I	**Credits**	3	**Course Code**	23KPISEC S2 12
		Semester	I				
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	-	5		
Pre-requisite		Undergraduate Level Statistical Models.					
Objectives of the Course		1. The course stresses on the concepts of statistical design and analysis in biomedical research, with special emphasis on clinical trials. 2. To learn and develop scientific view to study the statistical challenges of clinical comparison of two or more treatment					
Course Outline		**UNIT 1:** Introduction to clinical trials: need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multicenter trials. Data management: datadefinitions,casereportforms,databasedesign,datacollectionsystemsfor goodclinicalpractice.Bioavailability,pharmacokineticsand Pharma co dynamics, two- compartment model.					
		UNIT II: Design of clinical trials: parallel vs. cross-over designs, cross-sectional vs. longitudinal designs, objectives and endpoints of clinical trials, design of Phase I trials, design of single stage and multi-stage Phase II trials.					
		UNIT III: Design and monitoring of Phase III trials with sequential stopping, design of bio-equivalence trials. Inference for 2x2 cross over design: Classical methods of interval hypothesis testing for Bio equivalence, Baye's in methods, non parametric methods.					
		UNIT IV: Power and sample size determination, multiplicative (or log-transformed) model, ML method of estimation, assessment of inter and intra subject variability, detection of outlying subjects.Optimal crossover designs: Balaams design, Two-sequence dual design. Optimalfourperioddesigns.Assessmentofbioequivalenceformorethantwo drugs, Williams design.					
		UNIT V: Designs based on clinical endpoints: Weighted least squares method, log-linear models, generalize destimating equations. Drug interaction study, dose proportionality study, steady state analysis. Interim analysis and group sequential tests, alphas pen ding functions. Analysis of categorical data.					

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Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Agresti, Alan. (1996) An Introduction to Categorical Data Analysis, Wiley, New York. 2. 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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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Estimation Theory

Title of the Course		Estimation Theory					
Paper Number		IV					
Category	CC	Year	I	Credits	5	Course Code	23KP2S04
		Semester	II				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		5	1	-	6		
Pre-requisite		Undergraduate level Probability Theory.					
Objectives of the Course		1. To make the students to understand the basic concepts of the statistical estimationtheory. 2. To study the properties of ideal estimators like unbiasedness, consistency, sufficiency,completeness. 3. To educate various estimation methods like method of moments, method of maximumlikelihood, interval estimate, and Bayes estimate.					
Course Outline		**UNIT I:** Sufficient statistics, Neyman, Fisher Factorisation theorem, the existence and construction of minimal sufficient statistics, Minimal sufficient statistics and exponential family, sufficiency and completeness, sufficiency and invariance.					
		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 estimation, computational routines, strong consistency of maximum likelihood estimators, Asymptotic Efficiency of 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 estimation, interval estimation.					
Extended Professional Component (is a part of internal component only, Notto 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)					

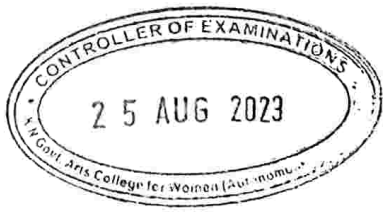
CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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



Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. V.K.Rohatgi etal(2002) : An introduction to probability and statistics, John Wiley.Lehmann, E.L. (1983): Theory of point estimation, John Wiley. M. Rajagopalan and P. Dhanavanthan (2012): Statistical Inference, PHI Learning Pvt Ltd, New Delhi.
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, 2nd 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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To 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.

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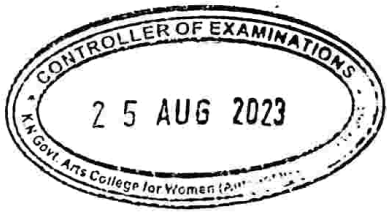
Measure and Probability Theory

Title of the Course	Measure and Probability Theory					
Paper Number	V					
Category: CC	Year: I	Credits: 5	Course Code: 23KP2505			
	Semester: II					
Instructional Hours per week	Lecture: 5	Tutorial: 1	Lab Practice: -	Total: 6		
Pre-requisite	Undergraduate level Mathematics, Probability and Random Variables.					
Objectives of the Course	1. This paper provides mathematical background for the knowledge of Probability Theoryextended from measure theoretical approach. 2. The students will be able to understand the basic concepts of the distribution function and random variables that help in understanding for estimation and testing problems inStatistical Inference. 3. The fundamentals of this course will pave the way for further research.					
Course Outline	**UNIT I:** Measure Theory - Limits of sequence of sets, classes of sets – 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.					
	UNIT III: Events, sample space, different approaches to probability, random variables and random vector, Distribution functions of random variables and random vector, Expectation and moments, basic, Markov, Chebyshev's, Holder's, Minkowski's and Jensen's inequalities.					
	UNIT IV: Independence of sequence of events and random variables, conditional probability, conditional expectation, Characteristic functions and their properties, inversion formula, convergence of random variables, convergence in probability, almost surely, in the r-th mean andin distribution, their relationships, convergence of moments, Helly-Bray theorem, continuity theorem and convolution of distributions.					
	UNIT V: Central limit theorem, statement of CLT, Lindeberg, Levy and Liapounov forms with proof and Lindeberg Feller's form examples. Khintchine weak law of large numbers, Kolmogorov inequality, strong law of large numbers.					



Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. 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. 2. Billingsley, P. (2012): Probability and Measure, John Wiley & Sons, Inc., Publication.
Reference Books	1. Parthasarthy, K.R. (1977): Introduction to probability and measure, MacMillan Co.,Breiman, L. (1968): Probability, Addison Wesley. 2. Munroe, M.E. (1971): Measure and integration, 2nd ed. Addison Wesley. Halmos, P.R.(1974): Measure theory, East-West. 3. 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 Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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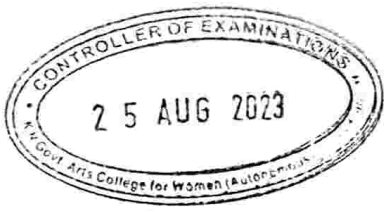
Time Series Analysis

Title of the Course		Time Series Analysis					
Paper Number		VI					
Category	CC	Year	I	Credits	4	Course Code	22KP2S06
		Semester	II				
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		5		1	-	6	
Pre-requisite		UG Level Time Series Modelling					
Objectives of the Course		1. Understanding of various components of time series and forecasting univariate time series 2. Apply different methods for fitting time series models 3. Understanding various important concepts in forecasting and smoothing methods 4. Understanding stationary and non-stationary nature of time series data					
Course Outline		**UNIT I:** Time Series – Introduction – components of time series – 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 – Mean absolute error,Mean error, Mean square error. Relative measures – Percentage error, Mean percentage error, Mean absolute percentage error.					
		UNIT III: Smoothing methods – Single exponential smoothing. Double exponential smoothing (Holtmethod). Triple exponential smoothing (Holt-Winter's method).					
		UNIT IV: Decomposition method: Additive and Multiplicative decomposition – Forecast and Confidence Intervals – Kruskal-Wallis test for seasonality - Moving average Forecasting – Spencer's and Henderson's moving averages (without derivation). Stationary and Non-stationary Time series- Autocorrelation function (ACF) and Partial Autocorrelation function (PACF)- Portmanteau tests:Ljung–Box test and Box–Pierce test.					



	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 Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction toLinear regression analysis, third edition, John Wiley and Sons, Inc. 2. Draper, N.R. and Smith, H. (2000) : Applied Regression Analysis, 2nd edition, John Wiley& 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 (1977): Regression Analysis by Examples, John Wiley& Sons. 2. George E.P. Box and Gwilym M. Jenkins (1976): Time Series Analysis – Forecastingand Control, Holdne – Day Inc. 3. Johnston J. (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 e-Learning Source	1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, 2. http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. Structuring the time series data based on seasonal and non-seasonal nature.
2. Identifying the stationarity of the time series
3. Modelling time series using exponential methods and Box-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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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GroupC:

Actuarial Statistics

Title of the Course		**ActuarialStatistics**					
Paper Number		**III**					
Category	**MBE**	**Year**	I	**Credits**	3	**Course Code**	23KP2SECS3:1
		Semester	II				
Instructional Hours perweek		**Lecture**		**Tutorial**	**LabPractice**	**Total**	
		3		1	-	4	
Pre-requisite		Basic Skills in Mathematical Computation					
Objectives of the Course		The main objectives of this courseare to: 1. Know the significance of mathematics in financial management. 2. Inculcate knowledge in computation of measures such as interest, discount, inflation, etc. 3. Understand the notions of Actuarial statistics.					
Course Outline		**UNITI:** Measures of Mortality:-Life tables and its relation with survival function- life table function at nonintegerage (fractionalages) –analytical laws of mortality-Gompertzand Makeham'slawsofmortality– Select, ultimate andaggregate mortalitytables.					
		UNIT II: Abridged life tables – construction of abridged life tables – methods by Read andMerrell, Greville's, Kings andJIA method.UtilityTheory–Insuranceand UtilityTheory.					
		UNIT III: Models for individual claim sand their sums–multiple lifefunction– joint lifestatus and last survival status.					
		UNIT IV: Policy Values:Natureo freserve-prospectiveandretrospective reserves - fractional premiums and fractional durations –modified reserves-Continuous reserves-Surrender values and paiduppolicies- Industrial assurance-Children's deferred assurances-Joint Life and last survivorship.					
		UNITV: Pension Funds: Capital sums onretirement and death-widow'spensions-Sicknessbenefits-Benefitsdependentonmarriage.					
ReferenceBooks		1. Bowers, N. L. (1997). Actuarial Mathematics, Society ofActuaries,SecondEdition. 2. Hossack,I.B. Pollard, J.H. and Zehnwirth, B.(1999)Introductorystatisticswithapplicationsingeneralinsurance,CambridgeUniversityPress, Cambridge. 3. Promislow, S. D. (2011). Fundamentals of ActuarialMathematics,JohnWileyandSons,NewYork.					

Course Learning Outcome (for Mapping with POs and PSOs)

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.

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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Simulation Analysis

Title of the Course	**Simulation Analysis**						
Paper Number	**VI**						
Category **ED**	**Year**	**I**	**Credits**	**3**	**Course Code**	23KP2SEC3: 2	
	Semester	**II**					
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	3		1		-	4	
Pre-requisite	Basic Skills in Mathematical Computation						
Objectives of the Course	The main objectives of this course are to: 1. Define the basics of simulation modeling and replicating the practical situations in organizations 2. Generate random numbers and random variates using different techniques. 3. Develop simulation model using heuristic methods. 4. Analysis of Simulation models using input analyzer, and output analyzer. 5. Explain Verification and Validation of simulation model.						
Course Outline	**UNI I:** Introduction to Simulation: Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System, Other simulation examples.						
	UNITII: General Principles: Concepts in discrete - event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling. Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test.						
	UNIT III: Random Variate Generation: Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique Optimization Via Simulation: Meaning, difficulty, Robust Heuristics, Random Search.						
	UNIT IV: Analysis of Simulation Data Input Modelling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation of Model – Model Building, Verification, Calibration and Validation of Models.						
	UNIT V: Output Analysis – Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations. Simulation Software's: Selection of Simulation Software, Simulation packages, Trend in Simulation Software.						

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability,Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. 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. 2. Shailaja R Deshmukh (2009) "Actuarial Statistics", University Press (India) Private Limited, Hyderabad.
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. 2. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4. 3. 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.

Course Learning Outcome (for Mapping with POs and PSOs)

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.

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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Group D:

Survival Analysis

Title of the Course	**Survival Analysis**						
Paper Number	**VIII**						
Category **ED**	**Year**	I	**Credits**	3	**Course Code**	23KP2SECS4:1	
	Semester	II					
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	3		1		-	4	
Pre-requisite	Basic knowledge in linear models and their properties						
Objectives of the Course	The main objectives of this course are to: 1. To learn the analysis of survival data. 2. To distinguish censored and uncensored data. 3. To visualize and communicate time-to event data, to fit and interpret failure time model.						
Course Outline	**UNIT I:** Concepts of time, Order and random Censoring, likelihood in these cases. Life distributions- Exponential, Gamma, Weibull, Lognormal, Pareto, Linear Failure rate. Parametric inference (Point estimation, scores, MLE)						
	UNIT II: Life tables, failure rate, mean residual life and their elementary properties. Concept of Ageing, Types of Ageing classes and their properties and relationship between them, Bathtub Failure rate, Concept of Inverse Hazard rate.						
	UNIT III: Estimation of survival function Actuarial Estimator, Kaplan-Meier Estimator, Estimation under the assumption of IFR / DFR. Tests of exponentiality against non- parametric classes- Total time on test, Despande test.						
	UNIT IV: Two sample problem- Gehan test, Log rank test. Mantel Haenszel test, Tarone Ware tests. Introduction to Semi- parametric regression for failure rate, Cox's proportional hazards(PH) model with one and several covariates and estimation problems in Cox's PH Model. Rank test for the regression coefficients.						
	UNIT V: Introduction to Competing risks analysis and estimation problems in competing risk model for parametric and non- parametric semi parametric set up. Ideas of Multiple decrement life table and its applications.						
Extended Professional Component (is a partof internal component only, Notto be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)						
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill						

Recommended Text Books	1. Miller, R.G. (1981): Survival analysis (John Wiley). 2. Cox, D.R. and Oakes, D. (1984) : Analysis of Survival Data, Chapman and Hall, New York.
Reference Books	1. Elisha T Lee, John Wenyu Wang and Timothy Wenyu Patt (2003): Statistical Methods for Survival data Analysis, 3/e, Wiley 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, John Wiley.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

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

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

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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Econometrics

Title of the Course	Econometrics					
Paper Number						
Category: ED	Year: I	Credits: 3	Course Code: 23KP2SECS4:2			
	Semester: II					
Instructional Hours per week	Lecture: 3	Tutorial: 1	Lab Practice: -	Total: 4		
Pre-requisite	Basic knowledge in linear models and their properties					
Objectives of the Course	The main objectives of this course are to: 1. Develop knowledge on concepts of methodology, nature and scope of Econometric analysis 2. Inculcate the ideas of applications of econometrics 3. Understand and explore the concepts of linear models 4. Explore prominent estimation methods for linear regression model and simultaneous equation models.					
Course Outline	**UNIT I:** Nature and scope of Econometrics - Illustrative Examples Production and cost analysis - Theory and analysis of consumer demand specification - Estimation of demand function- Price and income elasticity of demand - Price elasticity's of supply - Torquivists model of demand for inferior goods models building bias in construction of models.					
	UNIT II: Single equation linear model: static case - Ordinary least square model and generalized least squares model: Introduction - estimation and prediction - Problem of multi collinearity and heteroscedasticity – Causes, consequences and solutions of and estimation.					
	UNIT III: Autocorrelation: Causes, consequences and testing for auto-correlated disturbances - Autoregressive series of order 1 (AR(1)) - Lagged variables and distributed log methods - Errors in variable models and Instrumental variables. Economical Forecasting – long term and short term.					
	UNIT IV: Simultaneous equations model- Concept, structure and types - Identification Problem with restrictions on variance and covariance - Rank and order conditions of identifiability –Methods of estimation- Indirect least square method, two-stage least squares method of estimation and Estimation of Limited Information Maximum Likelihood (LIML).					
	UNIT V: K-Class estimators - Full information estimators - Full Information Maximum Likelihood (FIML) - Three stage least squares estimators (3-SLS) and its Properties - Comparison of various estimation methods.					
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)					

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Castle, J. and Shephard, N. (2009) The Methodology and Practice 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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

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

1. Understand the 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.

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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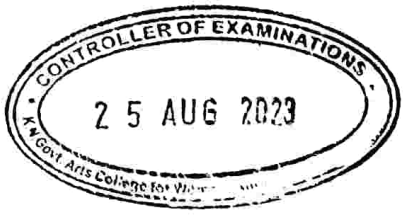
11.3.2 Practical .I – (Based on R Programming) CC IV & VI

Title of the Course		**Practical I – (Based on R Programming)**					
Paper Number		**II**					
Category	**SEC**	**Year**	**I**	**Credits**	**2**	**Course Code**	23KP2SSEC1P
		Semester	**II**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		1	**-**		3	4	
Pre-requisite		Basic knowledge of Estimation theory & Time Series Analysis					
Objectives of the Course		The main objectives of this course are to: 1. Understand the notions of Estimation theory by using R. 2. Impart application of Time Series Analysis in various domains of R.					
Course Outline		**Core IV: Estimation theory** 1. MLE and Standard error of ML estimators. 2. MLE through the method of successive approximation. 3. MLE for truncated distribution. 4. Method of Moments 5. Method of Minimum Chi-square 6. Method of Least square 7. Interval estimation: Confidence interval for mean, 8. Interval estimation - difference of means 9. Interval estimation - variance and ratio of variances **Core VI: Time Series Analysis** 10. Standard statistical measures for Time Series analysis: Absolute measures– Mean absolute error, Mean error, Mean square error. Relative measures – Percentage error, Mean percentage error, Mean absolute percentage error. 11. Smoothing methods–Single exponential smoothing. Double exponential smoothing (Holt method). 12. Triple exponential smoothing (Holt-Winter's method). 13. Auto correlation function (ACF) 14. Partial Auto – correlation function (PACF) 15. Portmanteautests:Ljung–Boxtest and Box–Piercetest.					
Recommended Text Books		1. Quick, J. M. (2010). Statistical Analysis with R, Packt Publishing Ltd., UK. 2. Purohit, S. G., Gore, S. D., and Deshmukh, S. R. (2009). Statistics Using R, Narosa 3. Dalgaard, P. (2008). Introductory Statistics with R, Second Edition, Springer					



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 e-Learning Source	1. https://swayam.gov.in/nd1_noc19_ma33/preview. 2. https://swayam.gov.in/nd2_aic20_sp35/preview. 3. https://nptel.ac.in/courses/111/104/111104100/

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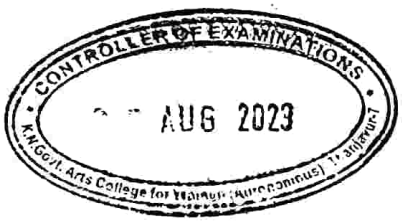
Extra Disciplinary Course (EDC):

For the other Departments (not for Statistics Students)

Statistics For Life Sciences

Title of the Course		**Statistics For Life Sciences**					
Paper Number		**I**					
Category	**EDC**	**Year**	**I**	**Credits**	**3**	**Course Code**	23KP2SECC1:1
		Semester	**II**				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
Pre-requisite		Basics in Probability distributions, sampling, testing of hypotheses.					
Objectives of the Course		The main objectives of this course are to: 1. Understand the application of statistics in Life sciences 2. To learn the Biological Assays. 3. Attain proficiency categorical data analysis.					
Course Outline		**Unit I:** Statistical Methods in Clinical Trials: Introduction to clinical trial and it's phases I, II, III and IV, statistical designs-fixed sample trials: simple randomized design, stratified randomized crossover design; Sequential design - open and close sequential design. Randomization Dynamic randomization, Permuted block randomization; Blinding-Single, double and triple.					
		Unit II: Biological Assays: Introduction, parallel-line assay, slope- ratio assays and quantile- response assay, Feller's theorem. Dose-response relationships-qualitative and quantitative response, dose response relation- estimation of median effective dose – PK-PD Analysis.					
		Unit III: Categorical Data Analysis: Categorical response data, logistic regression-odds ratio, Wald's statistic, logistic regression and its diagnostics, - Poison regression – Estimation of relative risk and its applications.					
		Unit IV: ROC Curve analysis - Estimation of Binomial Model and the Area under the Curve, its applications – Properties of ROC curve - Kullback –Leibler Divergence (KLD)– definition – functional relationship between Kullback –Leibler Divergence and the slope of the ROC curve – derivations of KLD expressions for Bi-normal ROC model.					
		Unit V: Repeated Measures ANOVA – One Way and Two Classified Data –Measures of disease frequency – incidence – prevalence – relative risk – Epidemiological study designs – Cohort study design and its analysis – Case control study design and its analysis – concept of bias – information bias and selection bias.					



Extended Professional Component (is a part of internal component only, Notto be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Myra L. Samuels, Jeffrey A. Witmer (2010): Statistics for Life Sciences, 5th 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, 2nd edn, (2015) W. H. Freeman and Company. Ben Roberts Pvt Ltd. 3. Elisa T.Lee & John Wenyu Wang (2003): Statistical methods for Survival Data analysis, 3rd Edition, John Wiley 3. 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 e-Learning Source	1. https://www.academia.edu/43317940/The Analysis of Biological Data Second Edition.

Course Learning Outcome (for Mapping with POs and PSOs)

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	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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Testing of Statistical Hypothesis

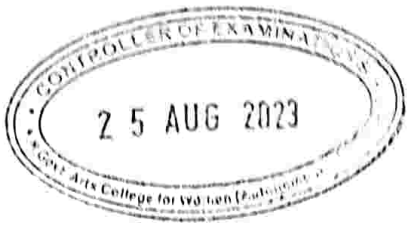
Title of the Course		**Testing of Statistical Hypothesis**					
Paper Number		**VII**					
Category	**CC**	**Year**	**II**	**Credits**	5	**Course Code**	23KP3S07
		Semester	**III**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		5	1		-	6	
Pre-requisite		Under Graduate Level Probability Theory and Testing of Statistical Hypothesis.					
Objectives of the Course		1. To get theoretical knowledge in Statistical Testing procedure 2. To provide knowledge about Most Powerful test and how to build it. 3. To understand Hypothesis testing concepts. 4. To develop analytical thinking in statistical testing of hypothesis.					
Course Outline		**UNIT I:** Uniformly most powerful tests, the Neyman-Pearson fundamental Lemma, Distributions with monotone likelihood ratio Problems.					
		UNIT II: Generalization of the fundamental lemma, two sided hypotheses, testing the mean and variance of a normal distribution.					
		UNIT III: Unbiasedness for hypotheses testing, similarly and completeness, UMP unbiased tests for multi parameter exponential families, comparing two Poisson or Binomial populations, testing the parameters of a normal distribution (unbiased tests), comparing the mean and variance of two normal distributions.					
		UNIT IV: Symmetry and invariance, maximal invariance, most powerful invariant tests.					
		UNIT V: SPRT procedures, likelihood ratio tests, locally most powerful tests, the concept of confidence sets, non-parametric tests.					

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. V.K.Rohatgi et a l(2002) : An introduction to probability and statistics, John Wiley. 2. Lehmann, E.L. (2005) : Testing of statistical hypothesis, 3rd 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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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



CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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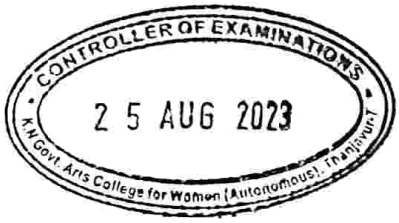
Linear Models

Title of the Course		Linear Models					
Paper Number		VIII					
Category	CC	Year	II	Credits	5	Course Code	23KP3S08
		Semester	III				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		5	1	-	6		
Pre-requisite		UG level linear regression analysis and Statistical Inference					
Objectives of the Course		1. To model cross sectional data using minimum number of parameters 2. To estimate unbiased estimators for model parameters 3. To estimate standard errors of estimates to construct the confidence intervals. 4. To test the goodness of fit of the models					
Course Outline		**UNIT I:** Linear Models – Classification, Estimability. The General Linear Hypothesis of Full Rank – Point Estimation (Estimation Under Normal Theory) – Gauss–Markov theorem, Tests of Hypothesis – Testing the Hypothesis $\beta = \beta^*$.					
		UNIT – II : Introduction to Generalized Linear Models: Components of Generalized Linear Model, Binomial Logit Model, Poisson Loglinear Model, Deviance, Linear Probability Model, Logistic Regression Model, Probit and Inverse CDF Link Function, GLM for Counts, Inference for GLM, Deviance and Goodness of Fit, Deviance for Poisson and Binomial Models.					
		UNIT – III: Methods of Estimations – ordinary least squares, generalized least square, maximize likelihood, BLUE.					
		UNIT – IV: General Linear Hypothesis – four common hypotheses – 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, 3-way classification – main and interaction effects - Models not of full rank.					



Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. S.R. Searle, Linear Models, John Wiley, 1971. 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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. 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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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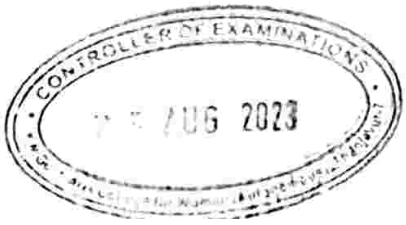
Multivariate Analysis

Title of the Course		**Multivariate Analysis**					
Paper Number		**IX**					
Category	**CC**	**Year**	**II**	**Credits**	5	**Course Code**	23KP3509
		Semester	**III**				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	-	6		
Pre-requisite		Univariate and Multivariate distribution theory , Linear Algebra					
Objectives of the Course		1. To impart basic theoretical knowledge about multivariate normal distribution, its properties to deal with multi-dimension data. To Derive inference based on multi-variate statistical analysis concerning Mean vector and Covariance matrix. 2. To provide requisite knowledge to handle multi-dimensional data with regard to dimensionality reduction using Principal Component and Factor Analysis. To imbibe skills to classify and assign a new item/object to any of the two or more populations using Discrimination and Classification. 3. To instruct theoretical knowledge to group variables or items that belong to multi- dimensional data using Cluster algorithms					
Course Outline		**UNIT I:** Multivariate Normal Distribution and Its Properties. Maximum Likelihood Estimators ofParameters, Distribution of Sample Mean Vector, Sample Dispersion Matrix.					
		UNIT II: Partial and multiple correlation coefficients- Null distribution - Application in testing. Null distribution of Hotelling's T^2 statistics. Application in tests on mean vector for one and moremultivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population					
		UNIT III: Classification and discrimination procedures for discrimination between two multivariate normal populations – Linear Discriminant function, Mahalanobis Distance, tests associated with Discriminant functions, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations.					
		UNIT IV: Principal component Analysis, Canonical variables and canonical correlation, clustering-similarity measures- hierarchical algorithms- Single Linkage, Non-hierarchical Clustering					
		UNIT V: Contingency Tables, Correspondence Analysis for Two Dimension Contingency Table					



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

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

1. To explain and interpret the importance of data that come from high dimensional 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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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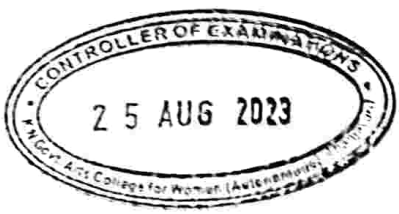
Design of Experiments

Title of the Course		Design of Experiments					
Paper Number		X.					
Category	CC	Year	II	Credits	4	Course Code	23KP3S10
		Semester	IV				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		5	1	-	6		
Pre-requisite		Matrix algebra & Linear Models.					
Objectives of the Course		1. To get theoretical knowledge in Statistical Design of Experiments and analysis of variance 2. To build strong theoretical foundation in Orthogonal latin squares, Hyper Graeco Latinsquares, factrorial and fractional factorial experiments, PIBD, inter and intra blocks, split plot, analysis covariance, Response surface methodology 3. To develop analytical thinking in problem solving skills					
Course Outline		**UNIT I:** Review of basic designs; Orthogonal latin squares, Hyper Graeco Latin squares – analysisof variance – multiple comparisons – multiple range tests - Missing plot technique.					
		UNIT II: General factorial experiments, study of 2 and 3 factorial experiments in randomized blocks; complete and partial confounding; Fractional designs for symmetric factorials; basic ideaof asymmetric factorials					
		UNIT III: General block design and its information matrix (C), criteria for connectedness, balanced and orthogonality; BIBD – recovery of interblock information; PBIBD(2).- Association scheme, Intrablock analysis, Lattice Design –analysis; Youden design – intrablock analysis;					
		UNIT IV: Nested and split plot designs – Two stage nested designs, split plot designs, split plot plot designs, strip-split designs, Analysis of covariance with one, two covariates; clinical trials.					
		UNIT V: Response surface methodology - first order and second order rotatable designs, applications					



Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Das, M.N. and Giri, N. (1979) : Design and analysis of experiments, Wiley Eastern. 2. John, P.W.M. (1971) : Statistical design and analysis of experiments, Macmillan.
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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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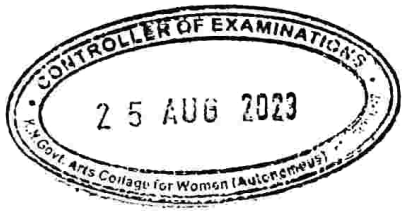
Semester III : Elective V (Elective V to be chosen from Group E)

Group E:

Operations Research

Title of the Course		**Operations Research**					
Paper Number		**XI**					
Category	**ED**	**Year**	I	**Credits**	3	**Course Code**	23KP3SECS5:1
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	1	--	3		
Pre-requisite		Undergraduate Level Linear Programming Problems					
Objectives of the Course		1. optimization techniques that will be useful in the personal and professional life. 2. To learn the mathematical formulation of complex decision-making problems and arrives at optimal or near-optimal solutions using different techniques of operations research.					
Course Outline		**UNIT I:** Mathematical Programming - Solving of LPP by graphical method - Linear Programming Problem (LPP)–Simplex, Big M and Two Phase methods –Solving LPP using Duality - Dual Simplex method.					
		UNIT II: Post Optimality and Sensitivity Analysis–Variation in cost vector and requirement vector– Addition and deletion of single variable and single constraint - Integer Programming Problem (IPP) - Gomory's cutting plane algorithm– Mixed IPP – Branch and Bound technique.					
		UNIT III: Dynamic programming problem (DPP) - Bellman's principle of optimality - General formulation - computation methods and application of DPP - Solving LPP through DPP approach.					
		UNIT IV: Non Linear Programming: Constrained and Unconstrained Problems of Maxima and minima, Constraints in the form of equations (Lagrangian Method) and in equations (KuhnTucker conditions), Quadratic programming: Beale's and wolf's methods simplex method for quadratic programming.					
		UNIT V: PERT - CPM: Applications, Basic Steps in PERT/CPM techniques; Time estimates and Critical Path in Network Analysis; Optimum and minimum duration cost, PERT, Resource Allocations.					
Extended Professional Component (is a partof internal component only, Notto be included in the External Examination question paper)		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)					
Skills acquired from this course		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					



Recommended Text Books	1. Hillier FS and Libermann GJ (2002): Introduction to Operations Research, 7 th Edition, McGraw Hill. 2. KantiSwarup,P.K.GuptaandManMohan(2004):OperationsResearch, Sultan Chand and Sons, New Delhi. 3. Gross D, Shortle J.F. , Thompson J.M. and Harris C.M. (2011): Fundamentals of Queuing Theory, John 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-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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Database Management Systems

Title of the Course	**Database Management Systems**						
Paper Number	**XII**						
Category	**ED**	**Year**	**I**	**Credits**	3	**Course Code**	23KP3SECS5:2
		Semester	**II**				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	2		1		-	3	
Pre-requisite	Basic knowledge in linear models and their properties						
Objective of the Course	The main objectives of this course are to: 1. To Understand the basic concepts and the applications of database systems 2. To Master the basics of SQL and construct queries using SQL 3. To understand the relational database design principles 4. To become familiar with the basic issues of transaction processing and concurrency control 5. To become familiar with database storage structures and access techniques						
Course Outline	UNIT I: Data base System Applications, Purpose of Database Systems, View of Data – Data Abstraction. Instances and Schemas – data Models – the ER Model – Relational Model – Other Models – Database Languages – DDL – DML – database Access for applications Programs – data base Users and Administrator – Transaction Management – data base Architecture – Storage Manager – the Query Processor. Data base design and ER diagrams – ER Model - Entities, Attributes and Entity sets – Relationships and Relationship sets – ER Design Issues – Concept Design – Conceptual Design for University Enterprise. Introduction to the Relational Model – Structure – Database Schema, Keys – Schema Diagrams.						
	UNIT II: Relational Query Languages, Relational Operations. Relational Algebra – Selection and projection set operations – renaming – Joins – Division – Examples of Algebra overviews – Relational calculus – Tuple relational Calculus – Domain relational calculus. Overview of the SQL Query Language – Basic Structure of SQL Queries, Set Operations, Aggregate Functions – GROUPBY – HAVING, Nested Sub queries, Views, Triggers.						
	UNIT III: Normalization – Introduction, Non loss decomposition and functional dependencies, First, Second, and third normal forms – dependency preservation, Boyee/Codd normal form. Higher Normal Forms - Introduction, Multi-valued dependencies and Fourth normal form, Join dependencies and Fifth normal form.						

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	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 – Estimating the cost – Equivalence Rules.
Extended Professional Component (is a partof internal component only, Notto be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / applied survey techniques adopted in Economics and Statistics department of Tamil Nadu State Government. (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Data base System Concepts, Silberschatz, Korth, McGraw hill, Sixth Edition. 2. Data base Management Systems, Raghurama Krishnan, Johannes Gehrke, TATA McGraw Hill 3rd Edition.
Reference Books	1. Fundamentals of Database Systems, Elmasri Navathe Pearson Education. 2. An Introduction to Database systems, C.J. Date, A.Kannan, S.Swami Nadhan, Pearson, Eight Edition.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Learning Outcome (for Mapping with POs and PSOs)

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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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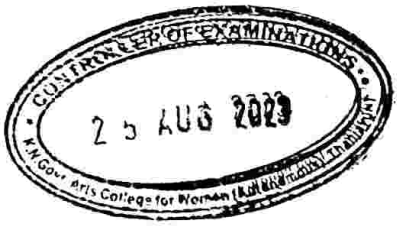
11.3.3 Practical II – (Based on Python)

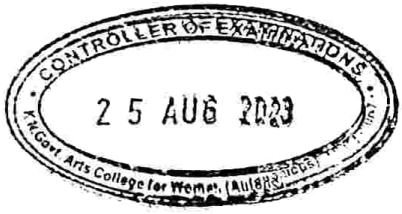
Title of the Course		**Practical II – (Based on Python)**					
Paper Number		**II**					
Category	**SEC**	**Year**	**II**	**Credits**	**2**	**Course Code**	23KP3SSEC2
		Semester	**III**				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		1		-	2	3	
Pre-requisite		Basic knowledge of Testing Statistical Hypothesis, Multivariate Statistical Analysis & Time Series Analysis					
Objectives of the Course		The main objectives of this course are to: 1. Understand the notions of Testing Statistical Hypothesis by using Python. 2. Impart application of Linear Models in Python. 3. Learn and write customized program for Multivariate Statistical Analysis through Python.					
Course Outline		**Core VII: Testing Statistical Hypothesis** 1. Construction of randomized and nonrandomized MP, UMP and UMPU tests of hypotheses and drawing the power curves. 2. Construction of SPRT and its OC and ASN curves. 3. 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 Models** 4. Fitting Logit and Probit Models. Decisions based on deviance and Goodness of fit. 5. Framing reduced model, null model and saturated model. 6. 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 for equality of mean vectors when covariance matrix is unknown (Hotelling's T^2 test) 8. Test for Two Covariance matrices 9. Discriminant Analysis 10. Canonical correlation and canonical variables 11. One Way MANOVA with Post hoc tests (DMRT and Tukey's). 12. Principal Component Analysis 13. Factor Analysis					



Recommended Text Books	1. Python for Data Analysis by O'Reilly Media (Second Edition) 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.

Optimization Techniques

Title of the Course		**Optimization Techniques**					
Paper Number		**II**					
Category	**EDC**	**Year**	**I**	**Credits**	3	**Course Code**	23KP3SECC3:1
		Semester	**II**				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		-				--	-
Pre-requisite		Basics in operations research.					
Objectives of the Course		The main objectives of this course are to: 1. Understand the problem formulation by using linear, dynamic programming, game theory and queuing models 2. Acquire knowledge on stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making 3. Formulation of mathematical models for quantitative analysis of managerial problems in industry					
Course Outline		**Unit I:** Development, definition, characteristics and phases, types of operation research models, applications; Allocation: linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two–phase method, big-M method.					
		Unit II: Transportation problem: Formulation, optimal solution, unbalanced transportation problem, Degeneracy; Assignment problem, formulation, optimal solution, variants of assignment problem, traveling salesman problem					
		Unit III: Sequencing: Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, and two jobs through "m" machines.					
		Unit IV: Theory of Games: Introduction – Terminology, Solution of games with saddle points and without saddle points, 2×2 games, dominance principle, m X 2 & 2 X n games, Graphical method.					
		Unit V: Waiting Lines: Introduction, Terminology, Single Channel, Poisson arrivals and exponential service times with infinite population and finite population models, Multichannel, Poisson arrivals and exponential service times with infinite population.					
Extended Professional Component (is a part of internal component only, Notto be included in the External Examination question paper)		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)					
Skills acquired from this course		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					



Recommended Text Books	1. J. K. Sharma, "Operations Research", Macmillan, 5th Edition, 2012. 2. R. Pannerselvan, "Operations Research", 2nd Edition, PHI Publications, 2006..
Reference Books	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 e-Learning Source	1. https://www.aicte-india.org/flipbook/p&ap/Vol.%20II%20UG/UG_2.html#p= 2. https://www.britannica.com/topic/operations-research

Course Learning Outcome (for Mapping with POs and PSOs)

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	M	S	S	M
CO2	S	M	S	S	M	M	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

*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 Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PSO's and CO's

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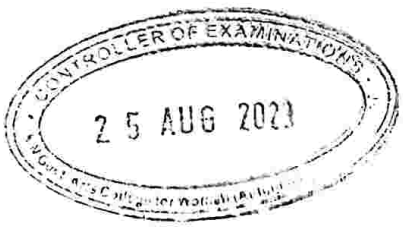
Stochastic Process

Title of the Course		**Stochastic Process**					
Paper Number		**XI**					
Category	**CC**	**Year**	**II**	**Credits**	5	**Course Code**	23KP4S11
		Semester	IV				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		5		1	-	6	
Pre-requisite		Probability theory and Distribution theory					
Objectives of the Course		1. To expose the basic concepts of the theory of stochastic processes and develops themathematical theory of random processes. 2. To understand the applications of Stochastic Process as a Mathematical tool. 3. To describe the advanced topics related to continuous and discrete time randomprocesses.					
Course Outline		**UNIT I:** Definition of Stochastic process – Specification of Stochastic Processes. Stationary Processes – Second order process, Stationarity, Gaussian processes. Martingales: Definition and properties. Martingales in discrete time - Supermartingales and submartingales - Continuous Parameter Martigales- Martingale convergence theorem and its applications					
		UNIT II: Markov chains – Definitions and examples. Higher order transition probabilities: Chapman – Kolmogrov equation. Classification of States and Chains – Determination of Higher Order Transition Probabilities -Aperiodic Chain: Limiting Behaviour. Stability of a Markov system.					
		UNIT III: Poisson process – Poisson process and related distributions. Pure Birth Process – Birth and Death process – Simple examples. Branching process – properties of generating function of branching process – Probability of extinction – fundamental theorem of branching process.					
		UNIT IV: Renewal theory - Renewal equation - Stopping time - Wald's equation - Elementary renewal theorem and its applications - Renewal reward processes - Residual and Excess life times - Markov renewal and Semi Markov processes					
		UNIT V: Queuing model M/M/1: Steady State Behaviour - Steady State Solution, Waiting time distribution. Queueing Model M/M/S - Steady State Solution, Waiting time distributions – simple problem.					



Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Medhi, J. (2017): Stochastic Processes, New Age International Publishing Limited, New Delhi. (Reprint 2002). 2. Karlin, S. and Taylor H.M. (1996): First Course in Stochastic Process, Academic Press. 3. Cox. D.R and Muller (1984) The Theory of Stochastic Process Chapman & Hall/crc, Boca Raton London New York.
Reference Books	1. Prabhu. N.U. (1965) : Stochastic Process, Macmillan, New York. 2. Ross, S.M (1996): Stochastic Processes, 2nd Edition, John Wiley & Sons, New Delhi.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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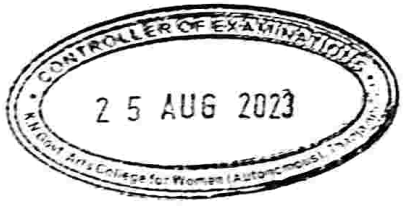
Title of the Course		Machine Learning Techniques					
Paper Number		CORE XII					
Category	Core	Year	II	Credits	5	Course Code	23KP4S12
		Semester	IV				
Instructional Hours perweek		Lecture		Tutorial		LabPractice	Total
		5		1		--	6
Pre-requisite		UG level Programming skill, Regression analysis					
Objectives of the Course		1. Acquire theoretical knowledge on setting hypothesis for pattern recognition. 2. Apply suitable machine earning techniques for data handling and to gain knowledge from it. 3. Evaluate the performance of algorithms and to provide solution for various real-world applications.					
Course Outline		**Unit I:** Data types – Measures of similarity and dissimilarity - Hierarchical Clustering Methods –k-means and k-medoids clustering methods– Clustering Validity measures					
		Unit II: Fuzzy c-means – Fuzzy Clustering Validity Measures – Decision Trees – Building adecision tree – Tree induction algorithm – Splitting of nodes based on information gain and Giniindex –Nearest Neighbor classifiers – k N Nalgorithm – Naïve Bayesian classifier					
		Unit III: Association rules mining–Basics–A priori 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: Ensemble Learning Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting : Adaboost, Stacking, Bayesian Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Mining Frequent Patterns.					



Extended Professional Component(is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from This course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Tan, T., Steinbach, M. and Kumar, V. (2006): Introduction to Data Mining, Pearson Education. Gupta, G.K.(2008):Introduction to Data Mining with case studies, Prentice – Hall of India Pvt. Ltd. Daniel T. Larose (2006): Data Mining: Methods and Models,JohnWileyand Sons. 2. Han, J. and Kamber, M. (2006): Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publishers.
ReferenceBooks	1. Paolo Gludici (2003): Applied Data Mining: Statistical Methods for Business and Industry, John Wileyand sons. 2. Rajan Chattamvelli (2009): Data Mining Methods, Narosa Publishing House, New Delhi. 3. Wayne, W.David(1987) : A foundation for analysis in Health Sciences 4th ed., John Wiley & Sons. Jerrold H.Zar(1984): Bio-statistical analysis, Prenticehall2nd ed. 4. Susan Milton, J.(1992) : Statistical methods in the biological and health sciences,McGraw Hill. Jain,J.R. (1982) : Statistical techniques in quantitative genetics, TataMcGraw Hill.
Websiteand e-LearningSource	e-books, onlinetutorialstakenfromMOOC/SWAYAM plat form for this subject.

Course Learning Outcome (for Mapping with Pos and PSOs)

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.

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

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

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

Level of Correlation between PSO's and CO's

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Elective VI to be chosen from Group F

Group F:

Non - Parametric Inference

Title of the Course		**Non - Parametric Inference**					
Paper Number		**XIII**					
Category	**ED**	**Year**	**II**	**Credits**	**3**	**Course Code**	23KP4SEC56:1
		Semester	**IV**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	**1**		**--**	**4**	
Pre-requisite		Undergraduate Level Non – Parametric methods					
Objectives of the Course		1. To familiarize the concepts of non- parametric tests 2. To Characterize, compare, and contrast different non-parametric hypothesis tests. 3. To Present and communicate, both orally and in written-form, the results of statistical analyses of non-parametric data.					
Course Outline		**UNIT I:** Nonparametric vs. Parametric statistical tests - Fundamental differences - Appropriate situations for use of nonparametric methods vs. parametric methods - Advantages and disadvantages of parametric tests - Power-efficiency of nonparametric tests relative to similar parametric tests.					
		UNIT II: The one-sample case - Binomial test, Chi-Square test 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, Chi-Square test for independent samples, Median test, Mann-Whitney U-test, Kolmogorov-Smirnov test, Wald-Wolfowitz test.					
		UNIT IV: The case of k related samples - Cochrane Q - test, Friedman two-way analysis of variance by ranks. The case of k independent samples Chi-Square test for k independent samples, Kruskal-Wallis one-way analysis of variance by ranks.					
		UNIT V: Nonparametric correlation - the contingency coefficient C, Spearman rank correlation, Kendall rank correlation, Kendall partial correlation coefficient - nonparametric linear regression.					
Extended Professional Component (is a partof internal component only, Notto be included in the External Examination question paper)		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)					

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. A Distribution-Free Theory of Nonparametric Regression (Springer Series in Statistics) Paperback – Import, 4 December 2010. 2. Gibbons J.D. (1971): Nonparametric Inference, McGraw- Hill.
Reference Books	1. Hardle (1990): Applied Non-parametric Regression, Cambridge University Press. 2. Hart J.D. (1997): Non-parametric Smoothing and Lack of Fit Tests, Springer Verlag. 3. Takezawa K. (2005): Introduction to Non-parametric Regression - Wiley Series in Probability and Statistics, John Wiley and Sons.
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for thissubject.

Course Learning Outcome (for Mapping with POs and PSOs)

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	M	M	M	S	M	S	M	M
CO2	S	S	S	S	M	S	M	S	M	M
CO3	S	S	S	M	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	M	M
CO5	S	S	S	S	M	S	S	S	M	M

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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11.2.6.2 Reliability Theory

Title of the Course		**Reliability Theory**					
Paper Number		**XIV**					
Category	**ED**	**Year**	**II**	**Credits**	**3**	**Course Code**	23KP4SECS6 : 2
		Semester	**IV**				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	1		-	4	
Pre-requisite		Undergraduate Level Probability distributions & Queueing models.					
Objectives of the Course		1. Provide an insight into various tools and techniques of Reliability. 2. Review the various mathematical, physical and logical modeling tools for estimation and evaluation of component and system level reliability. 3. Appraise failure phenomena and there by provide valuable inputs for product design to achieve higher levels of reliability standards. 4. Assessment and evaluation of reliability goals and their improvements.					
Course Outline		**UNIT 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 & irrelevant structure; Modules of coherent systems; Reliability of a coherent systems; Reliability importance of components; Bounds on System Reliability.					
		UNIT II: Life Distributions: Concept of distribution function, hazard function, Reliability function, MTTF, Bathtub failure rate; loss of memory property of Exponential distribution – parametric families of some common life distributions – Exponential, Weibull and Gamma and its characterization - Reliability estimation of parameters in these models.					
		UNIT III: Notions of Ageing; Classes of life distributions and their duals - preservation of life distribution classes for reliability operation – Formation of coherent systems, convolutions and mixtures.					
		UNIT IV: Univariate stock models and life distributions 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. Maintenance and replacement policies; availability of reparable systems; modeling of a repairable system by a non-homogeneous Poisson process.					
		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 Component (is a partof internal component only, Not to be included in theExternal Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text Books	1. Barlow, R.E. and Proschan F. (1985) Statistical Theory of 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): Introdcution to Reliability Analysis, Springer Verlag. 4. Marshall, A.W. and Olkin I(2007): Life Distributions, Spring
Website and e-Learning Source	e-books, online tutorials taken from MOOC/SWAYAM platform for this subject.

Course Outcomes (for Mapping with POs and PSOs)

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.

CO-PO Mapping (Course Articulation Matrix)

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

S-Strong, M-Medium, W-Weak

Level of Correlation between PSO's and CO's

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

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