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| M.sc., STATISTICS |
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| **SYLLABUS** |
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|  |
|  **from the acadmic year** **2023-2024** |
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| **TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005** |

# CONTENTS

1. **Preamble**

# Structure of Course

1. **Learning and Teaching Activities**

# Tutorial Activities

1. **Laboratory Activities**

# Field Study Activities

1. **Assessment Activities**

# Assessment principles

* 1. **Assessment Details**

# Teaching methodologies

1. **Faculty Course File**

# Template for PG Programme in Statistics

1. **Template for Semester**

# Instructions for Course Transaction

1. **Testing Pattern**

# Different Types of Courses

1. **Elective Courses (ED from other Department Experts)**

# Skill Development Courses

1. **Institution-Industry-Interaction**

# Model Syllabus

# Cognitive Domain

**(Lower levels: K1: Remembering ; K2: Understanding ; K3: Applying; Higher levels: K4: Analysing ; K5: Evaluating; K6: Creating)**

# Affective Domain

1. **Psychomotor Domain**

# 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 thecourse) [ 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 componentonly, 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 theExternal Examination questionpaper) |  |  |
| Skills acquired from thecourse | Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill |  |
| **Learning Resources:*** **Recommended Texts**
* **Reference Books**
* **Web resources**
 |
| **Board of Studies Date:** |

# Learning and Teaching Activities

* 1. **Topic wise Delivery method**

|  |  |  |  |
| --- | --- | --- | --- |
| **Hour Count** | **Topic** | **Unit** | **Mode of Delivery** |
|  |  |  |  |

# Work Load

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

|  |  |  |
| --- | --- | --- |
| **Activity** | **Quantity** | **Workload periods** |
| Lectures | 60 | 60 |
| Tutorials | 15 | 15 |
| Assignments | 5 | 5 |
| Cycle Test or similar | 2 | 4 |
| Model Test or similar | 1 | 3 |
| University Exam | 1 | 3 |
| Total | 90 periods |

# Tutorial Activities

|  |  |
| --- | --- |
| **Tutorial****Count** | **Topic** |
|  |  |

# Laboratory Activities

1. **Field Study Activities**

# Assessment Activities

* 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 enable robust and fair judgments about student 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.

# Assessment Details:

|  |  |  |  |
| --- | --- | --- | --- |
| **Assessment Item** | **Distributed Due Date** | **Weightage** | **Cumulative****Weightage** |
| Assignment 1 | 3rd week | 2% | 2% |
| Assignment 2 | 6th Week | 2% | 4% |
| Cycle Test – I | 7th Week | 6% | 10% |
| Assignment 3 | 8th Week | 2% | 12% |
| Assignment 4 | 11th Week | 2% | 14% |
| Cycle Test – II | 12th Week | 6% | 20% |
| Assignment 5 | 14th Week | 2% | 22% |
| Model Exam | 15th Week | 13% | 35% |
| Attendance | All weeks as per theAcademic Calendar | 5% | 40% |
| University Exam | 17th Week | 60% | 100% |

# CONTENTS

1. Academic Schedule
2. Students Name List
3. Time Table
4. Syllabus
5. Lesson Plan
6. Staff Workload
7. Course Design(content, Course Outcomes(COs), Delivery method, mapping of COs with Programme Outcomes(POs), Assessment Pattern in terms of Revised Bloom’s Taxonomy)
8. Sample CO Assessment Tools.
9. Faculty Course Assessment Report (FCAR)
10. Course Evaluation Sheet
11. Teaching Materials (PPT, OHP etc)
12. Lecture Notes
13. Home Assignment Questions
14. Tutorial Sheets
15. Remedial Class Record, if any.
16. Projects related to the Course
17. Laboratory Experiments related to the Courses
18. Internal Question Paper
19. External Question Paper
20. Sample Home Assignment Answer Sheets
21. Three best, three middle level and three average Answer sheets
22. Result Analysis (CO wise and whole class)
23. Question Bank for Higher studies Preparation (GATE/Placement)
24. 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 to have

|  |  |
| --- | --- |
| **Programme Outcomes (Pos)** | **PO1: Disciplinary Knowledge:**a good theoretical knowledge of the domain Statistics and its methods and techniques.**PO2: Mathematical knowledge:**sharpening mathematical knowledge needed to understand higher levels of Statistics understand multidimensional issues of data.**PO3: Application knowledge:**understanding application of Statistics in various domain. Also understand the interdisciplinary nature of Statistics while applying it. Industrial oriented programming languages are introduce to undertake and solve practical problem in industry.**PO4: Critical Thinking:** examine basic statistical issues in a more logical and methodical manner in a real data given.**PO5: Analytical Reasoning:**to develop capability to identify logical issues in practicing with data, analyze and synthesize data from a variety of sources and accordingly 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. Also get 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: Communication and soft skills:**Interactive skills and presentation skills |
| **Programme Specific Outcomes****(PSOs)** | **PSO1 – Placement**To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.**PSO 2 - Entrepreneur**To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.**PSO3 – Research and Development**Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.**PSO4 – Contribution to Business World**To produce employable, ethical and innovative professionals to sustain in the dynamic business world.**PSO 5 – Contribution to the Society**To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

# 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% Theory80% 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**

# Illustration – I

**Credit Distribution for PG Programme in Statistics M.SC., STATISTICS**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **First Year Semester-I** | **Credit** | **Hours per****week(L/T/P)** |
|  | CC1 - Real Analysis & 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 ) |
| Elective III (Generic / Discipline Specific)(One from Group C) | 3 | 4 (3L + 1T) |
| Elective-IV(Computer / IT related) (One from Group D) | 3 | 4 (3L + 1T ) |
|  | Skill Enhancement Course -SEC 2, 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**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Second Year - 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 -SEC 3 : Practical – III (Core VII, VIII & IX Based on Python) NME | 2 | 3 |
| Internship / Industrial Activity(Carried out in Summer Vacation at the end of I year – 30 hours) | 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 (2 hours)
* General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours)

OR Statistics for Advanced Research Studies (2 hours) | 2 | 4 |
|  | Extension Activity | 1 |  |
|  | **Total** | **23** | **30** |

# TOTAL CREDITS: 91

# Consolidated Table for Credits Distribution

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Category of Courses | Credits for eachCourse | Number of Courses | Number of Credits in each Category ofCourses | Total Credits | Total Credits for theProgramme |
| Core | 4 | 12 | 48 | 72 | 80 (CGPA) |
| Project withviva voce | 3 | 1 | 3 |
| Industryaligned Programmes- | 3 | 1 | 3 |
| Elective (Generic and DisciplineCentric) | 3 | 6 | 18 |
|  (i) | Skill Enhancement (Term paper and Seminar & Generic / Discipline - Centric Skill Courses) (Internal AssessmentOnly) | 2 | 4 | 8 | 8 |
|  (ii)(iii) | AbilityEnhancement (Soft skill) | 2 | 4 | 8 | 10 | 11 (Non CGPA) |
| Summer Internship | 1 | 2 | 2 |
|  | ExtensionActivity | 1 | 1 | 1 | 1 |
|  |  | 91 |

# Template for Semester

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Category** | **Title of the Paper** | **Marks****(Max 100)** | **Duration for UE** | **Credits** |
| **CIA** | **UE** |
| **Semester –I** |
| Part A | Core I |  | 25 | 75 | 3 Hrs | 4 |
| Core II |  | 25 | 75 | 3 Hrs | 4 |
| Core III |  | 25 | 75 | 3 Hrs | 4 |
| Elective I | Elective-I (Choose one fromGroup-A) | 25 | 75 | 3 Hrs | 3 |
| Elective II | Elective-I I (Choose one from Group-B) | 25 | 75 | 3 Hrs | 3 |
| Part B | SkillEnhancement Course -SEC 1 | Practical – I (Core II & III Based on R Programming) | 25 |  75 |  3 Hrs | 2 |
| Ability EnhancementCourse (AECC 1) | Soft Skill I | Performance based assessment | 2 |
| **Semester-II** |
| Part A | Core IV |  | 25 | 75 | 3 Hrs | 4 |
| Core V |  | 25 | 75 | 3 Hrs | 4 |
| Core VI |  | 25 | 75 | 3 Hrs | 4 |
| Elective III | Elective-III(Choose one from Group-C) | 25 | 75 | 3 Hrs | 3 |
| Elective IV | Elective-IV (Choose one fromGroup-D) | 25 | 75 | 3 Hrs | 3 |
| Part B | Skill EnhancementCourse -SEC 2 | Practical – II (Core IV & VI Based on R Programming) | 25 |  75 |  3 Hrs | 2 |
| Ability EnhancementCourse (AECC 2) | Soft Skill II | Performance based assessment | 2 |

|  |
| --- |
| **Semester-III** |
| Part A | Core VII |  | 25 | 75 | 3 Hrs | 4 |
| Core VIII |  | 25 | 75 | 3 Hrs | 4 |
| Core IX |  | 25 | 75 | 3 Hrs | 4 |
| Elective / ED V | Elective-VI /ED-V (Choose one fromGroup-E) | 25 | 75 | 3 Hrs | 3 |
| Core Industry Module | ED-IV(Choose fromoutside the Department) Statistical Quality Control | 25 | 75 | 3 Hrs | 3 |
| Part B |  |
|  | Skill based (Term paper and Seminar) | Practical – III (Core VII, VIII & IX Based on Python) | 25 | 75 |  3 Hrs | 2 |
| Ability EnhancementCourse (AECC 3) | Soft Skill III | Performance based assessment | 2 |
| Internship / Industrial - Vacation Activity | 2 |
| **Semester-IV** |
|  | Core X |  | 25 | 75 | 3 Hrs | 4 |
| Core XI |  | 25 | 75 | 3 Hrs | 4 |
| Core XII |  | 25 | 75 | 3 Hrs | 4 |
| Project with vivavoce XIII |  | 25 | 75 | 3 Hrs | 3 |
| Elective VI | Elective-VI(Choose one from Group – F) | 25 | 75 | 3 Hrs | 3 |
|  | Skill EnhancementCourse -SEC 4 | Professional Competency SkillEnhancement Course | Internal Assessment | 2 |
| Ability EnhancementCourse (AECC4) | Soft Skill IV | Performance based assessment | 2 |
|  | ExtensionActivity | Performance based assessment | 1 |
| **Total Credits** | **91** |

# Elective Courses

**Courses are grouped (Group A to Group F) 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 stakeholders / 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. Survival Analysis
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-parametric Inference
2. Reliability Theory

# Skill Enhancement Courses

**Skill Enhancement Courses are chosen so as to keep in pace with the latest developments in the 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
	+ Research Tools and 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 | Lecturehrs | Tutorialhrs | Lab Practice | Totalhrs |
| Core | 75 | 15 | -- | 90 |
| Electives | 75 | 15 | -- | 90 |
| ED | 75 | 15 | -- | 90 |
| Lab Practice Courses | 45 | 15 | 30 | 90 |
| Project | 20 | -- | 70 | 90 |

1. **Testing Pattern (25+75) 13.1Internal Assessment**

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

**Computer Laboratory Courses:** For Computer Laboratory oriented Courses, there shall be two tests in Theory part and two tests in Laboratory part. Choose one best from Theory part and other best from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 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.

# Different Types of Courses

1. **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

# 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

# Elective Courses (ED from other Department Experts)

1. **Skill Development Courses**

# Institution-Industry-Interaction ( Industry aligned Courses)

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

# Model Syllabus for different Courses of M.Sc Statistics

|  |  |
| --- | --- |
| **Title of the Course** | **Real Analysis and Liner Algebra** |
| **Paper Number** | **CORE I** |
| **Category** | Core | **Year** | I | **Credits** | 4 | **Course Code** |  |
| **Semest****er** | I |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
| 5 | 1 | -- | 6 |
| **Pre-requisite** | Undergraduate level Vector Algebra and Matrix Theory |
| **Objectives of the Course** | 1. To provide recollection as well as building Mathematical foundation in Real Analysis and Matrix Theory
2. To understand concepts and definition of metric space 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
4. To know Linear space and its basis. Rank of a matrix, characteristic roots and its multiplicity, Different types of inverses, numerical examples and real life application
5. To know Different types of matrices, orthogonality, canonical forms, decomposition of matrix, quadratic forms, numerical examples and real life applications
 |
| **Course Outline** | **UNIT-I :** Metric Space – open, closed sets – Intervals (rectangles), Real valued Continuous functions- Discontinuities - compact sets, Bolzano – Weirstrass theorem, Heine – Borel theorem. |
| **Unit II:** Derivatives - maxima and minima - Riemann integral & Riemann – Stieltjes integral with respect an increasing integrator – properties of R.S. integral. Functions of several variables, constrained and unconstrained maxima – minima of functions, partial and total derivatives |
| **Unit III:** Basic properties of matrices (orthogonal, idempotent, Kronecker product, projection operators etc); Linear dependence, independence and rank of a matrix; characteristic roots and polynomial, multiplicity of characteristic roots; Cayley Hamilton theorem; inverse of a matrix and determinants; |
| **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 value decomposition, spectral decomposition, Cholesky decomposition etc. |
| **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 quadratic forms. |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examinationquestion 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 thisCourse | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |

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

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

Students will be able to

 **CLO 1:** Get a Mathematical foundation in Real analysis and Matrix Theory to understand univariate

 and multivariate concepts in Statistical Theory

 **CLO 2:** Get a clear understanding R.S. integral, partial differentiation in several variable functions,

 get theoretical knowledge by understanding the need and application of theorems like Bolzano –

 Weirstrass theorem, Heine– Borel theorem

 **CLO 3:** Understand concepts in matrix theory -rank and factorization, inverse of matrix, g-inverses

 and its applications, characteristic roots and its multiplicity, canonical forms and decomposition of

 matrix, orthogonality, quadratic forms and its index, solving linear system

 **CLO 4:** Able to get solve numerical problems and evaluate and interpret outcome

 **CLO 5:** analyze real life problems and explore research problems

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **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 |

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Sampling Methods** |
| **Paper Number** | **CORE II** |
| **Category** | Core | **Year** | I | **Credits** | 4 | **Course****Code** |  |
| **Semester** | I |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
| 5 | 1 | -- | 6 |
| **Pre-requisite** | Undergraduate Statistical Inference |
| **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.
 |
| **Course Outline** | **UNIT-I :** Preliminaries – Simple Random Sampling - PPS selection methods |
| **UNIT-II :** Midzuno sampling method – PPSWR and PPSWOR sampling methods – Ordered and Unordered estimators |
| **UNIT-III :** Stratified Sampling – Allocation Problems – Systematic Sampling Methods – Balanced, Modified and Centered systematic sampling methods – Yates corrected estimator. |

|  |  |
| --- | --- |
|  | **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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |

|  |  |
| --- | --- |
| **Recommended****Text** | 1. S.Sampath (2005) : Sampling Theory and Methods, Narosha Publishing House.
2. W.G. Cochran (1965) : Sampling Techniques, Wiley and Sons
 |
| **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-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 apply basics and advanced levels of sampling methods for different types of data.
2. To draw a conclusion about the best sampling procedure.
3. To use practical applications of ratio and regression method of estimations.
4. To analyze data from multi-stage sampling methods.
5. To estimate the hidden responses using randomized response techniques.

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

|  |  |
| --- | --- |
| **Title of the Course** | **Distribution Theory** |
| **Paper Number** | **CORE III** |
| **Category** | Core | **Year** | I | **Credits** | 4 | **Course****Code** |  |
| **Semester** | I |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
| 5 | 1 | -- | 6 |
| **Pre-requisite** | Undergraduate level Mathematics. |
| **Objectives of the Course** | 1. To provide theoretical 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.
 |
| **Course Outline** | **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 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 III:** Sampling distributions, non-central chi-square distribution, t and F distributions and their properties, distributions of quadratic forms under normality and related distribution theory – Cochran’s and James theory. |
| **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, distributions classified by hazard rate. |

|  |  |
| --- | --- |
| Extended Professional Component (is a part of internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended****Text** | 1. Gibbons (1971) : Non-parametric inference, Tata McGraw Hill.
2. Rohatgi, V.K. and Md. Whsanes Saleh, A.K.(2002): An introduction to probability & Statistics, John Wiley and Sons.
 |
| **Reference Books** | 1. Rao, C.R. (1973) : Linear statistical inference and its applications, 2ed, Wiley Eastern.
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, 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)

Students will be able to

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

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

|  |  |
| --- | --- |
| **Title of the Course** | **Estimation Theory** |
| **Paper Number** | **CORE IV** |
| **Category** | Core | **Year** | I | **Credits** | 4 | **Course****Code** |  |
| **Semester** | II |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
| 5 | 1 | -- | 6 |
| **Pre-requisite** | Probability Theory. |
| **Objectives of the Course** | 1. To make the students to understand the basic concepts of the statistical estimation theory.
2. To study the properties of ideal estimators like unbaisedness, consistency, sufficiency, completeness.
3. To educate various estimation methods like method of moments, method of maximum likelihood, 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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended****Text** | 1. V.K.Rohatgi etal(2002) : An introduction to probability and statistics, John Wiley. Lehmann, E.L. (1983): Theory of point estimation, John Wiley.
 |

|  |  |
| --- | --- |
| **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.
4. 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, Interval estimation and shortest with confidence intervals.
5. To learn the concepts and to apply simple numerical illustration for Loss function, Risk function and Bayes estimate.

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

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Measure and Probability Theory** |
| **Paper Number** | **CORE V** |
| **Category** | Core | **Year** | I | **Credits** | 4 | **Course****Code** |  |
| **Semester** | II |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
| 5 | 1 | -- | 6 |
| **Pre-requisite** | Undergraduate level Mathematics. |
| **Objectives of the Course** | 1. This paper provides mathematical background for the knowledge of Probability Theory extended 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 in Statistical 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, convergence in 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 and in distribution, their relationships, convergence of moments, Helly-Bray theorem, continuity theorem and convolution of distributions. |

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|  | **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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended Text** | 1. Bhat, B.R. (1985): Modern probability theory, 2nd ed. Wiley Eastern. Chow, Y.S. and Teicher, H. (1979): Probability theory, Springer Verlag. Chung, K.L. et al: A course in probability theory, Academic press.
 |
| **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 this subject. |

# 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 Conditional Probability.
4. Demonstrate the ability to apply basic methods in analyzing the convergence in Probability and rth mean and in Distribution and Characteristics functions.
5. Demonstrate critical thinking skills, such as problem solving using weak and strong law of large numbers and different forms of Central Limit Theorems.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **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 |

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Time Series Analysis** |
| **Paper Number** | **CORE VI** |
| **Category** | Core | **Year** | I | **Credits** | 4 | **Course****Code** |  |
| **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 series2. Apply different methods for fitting time series models3.Understanding various important concepts in forecasting and smoothing methods4. 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 (Holt method). 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- Auto correlation function (ACF) and Partial Auto correlation 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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended Text** | 1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear 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), Forecasting Methods and Applications – Second Edition, John Wiley & Sons.
4. T.M.J.A.Cooray(2008): Applied Time Series Analysis and Forecasting, NAROSA publishing house Pvt.Ltd
 |
| **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 – Forecasting and Control, Holdne – Day Inc.
3. Johnston J. (1984) : Econometric Methods, (3rd Edition), McGraw Hill International Book Company, New Delhi.
4. Singh, Parashar and Singh (1997): Econometrics and Mathematical Economics (1st Edition), S. Chand & Co, New Delhi.
 |
| **Website and****e-Learning Source** | [http://mathforum.org](http://www.mathforum.org/), [http://ocw.mit.edu/ocwweb/Mathematics,](http://ocw.mit.edu/ocwweb/Mathematics)[http://www.opensource.org](http://www.opensource.org/), [www.mathpages.com](http://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 sationarity 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

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

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Testing of Statistical Hypothesis** |
| **Paper Number** | **CORE VII** |
| **Category** | Core | **Year** | II | **Credits** | 4 | **Course****Code** |  |
| **Semester** | III |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **Total** |
| 5 | 1 | -- | 6 |
| **Pre-requisite** | Probability Theory |
| **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 concepts Unbiasedness for hypotheses testing, invariance, Likelihood Ratio tests and SPRT test
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. |

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| Extended Professional Component (is a part of internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended****Text** | 1. V.K.Rohatgi et a l(2002) : An introduction to probability and statistics, John Wiley.
2. Lehmann, E.L. (1986) : Testing of statistical hypothesis, 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 this subject. |

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

Students will be able to

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

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

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Linear Models** |
| **Paper Number** | **CORE VIII** |
| **Category** | Core | **Year** | II | **Credits** | 4 | **Course****Code** |  |
| **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 β = β\*. |
| **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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended****Text** | 1. S.R. Searle, Linear Models, John Wiley, 1971.
 |
| **Reference Books** | 1. Alan Agresti, (2002): Categorical Data Analysis, WileyInterscience, John Wiley& Sons1. 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 this subject. |

# 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

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

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Multivariate Analysis** |
| **Paper Number** | **CORE IX** |
| **Category** | Core | **Year** | II | **Credits** | 4 | **Course****Code** |  |
| **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 of Parameters, 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 T2 statistics. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of a mean vector in a multivariate normal population |
| **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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended****Text** | 1. Anderson, T.W. (1983): An Introduction To Multivariate Statistical Analysis. 2nd Ed.Wiley.
2. Johnson,R.& Wichern(2008): Applied Multivariate Statistical Analysis, Pearson, 6ed
 |

|  |  |
| --- | --- |
| **Reference Books** | 1. Brain S. Everitt and Graham Dunn (2001): Applied Multivariate Data Analysis, 2nd Ed.(chap 4)
2. Neil H.Timm (2002): Applied Multivariate Analysis –Springer-Verlag
3. Dallas E.Johnson (1998) :Applied Multivariate Methods For Data Analysts- Duxbury Press
4. William R Dillon and Mathew Goldstein (1984): Multivariate Analysis Methods And Applications, John 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 setup using appropriate properties.
2. To draw inference based on multi-variate statistical analysis concerning Mean vector and Covariance matrix.
3. To reduce dimensions and identify factors from multi-dimensional data using Principal Component and Factor Analysis respectively.
4. To classify and assign a new item/object to any of the two or more populations using Discrimination and Classification.
5. To group variables or items that belong to multi-dimensional data using Cluster algorithms.

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

**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**

|  |  |
| --- | --- |
| **Title of the Course** | **Design of Experiments** |
| **Paper Number** | **CORE X** |
| **Category** | Core | **Year** | II | **Credits** | 4 | **Course****Code** |  |
| **Semester** | III |
| **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 Latin squares, 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 – analysis of 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 idea of 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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended****Text** | 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, New York.
2. Robert, O., Kuelhl(2000) : Design of experiments. Statistical principles of research design and analysis, Duxbury.
3. Federer, W.T.(1963) : Experimental design; Theory and application, Oxford & IBH publishing Co.
 |
| **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 analysis of variance and experimental designs
2. To have strong theoretical knowledge in Orthogonal latin squares, Hyper Graeco Latin squares, factrorial and fractional factorial experiments, PIBD, inter and intra blocks, split plot, analysis covariance
3. To understand clinical trial concepts and Response surface methodology
4. To do numerical problems and able to get critical thinking to solve problems
5. To choose suitable experiment and do it for real life problems.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | S | S | S | S | S | S | S | S | M |
| **CO2** | S | S | M | S | M | S | S | S | M | M |
| **CO3** | S | S | S | M | S | S | S | S | S | M |
| **CO4** | S | S | S | S | S | S | S | M | M | M |
| **CO5** | S | S | S | M | M | S | S | S | 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 |
|  |  |  |  |  |  |
|  |  |
| **Title of the Course** | **Stochastic Process** |
| **Paper Number** | **CORE XI** |
| **Category** | Core | **Year** | II | **Credits** | 4 | **Course****Code** |  |
| **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 the mathematical theory of random processes.
2. It provides the fundamentals and advanced concepts of probability theory and help them appreciate and understand the application of the mathematical tool.
3. To describe the advanced topics related to continuous and discrete time random processes.
 |
| **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. |

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| Extended Professional Component (is a part of internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, Professional Communication and Transferrable Skill |
| **Recommended Text** | 1. Medhi, J. (1984): 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.
 |
| **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 this subject. |

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

Students will be able to

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **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**

|  |  |
| --- | --- |
| **Title of the Course** | **Machine Learning Techniques** |
| **Paper Number** | **CORE XII** |
| **Category** | Core | **Year** | II | **Credits** | 4 | **Course Code** |  |
| **Semester** | IV |
| **Instructional Hours****per week** | **Lecture** | **Tutorial** | **Lab Practice** | **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 learning 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 a decision tree – Tree induction algorithm – Splitting of nodes based on information gain and Gini index - Nearest Neighbor classifiers – kNN algorithm – Naïve Bayesian classifier |
| **Unit III:** Association rules mining – Basics – Apriori algorithm – Pruning and candidate generation – Rule mining. Machine learning – Introduction - Examples of various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces, PAC Learning, VC Dimension. |
| **Unit IV:** Learning a Class from Examples, Linear, Non-linear, Multi-class and Multi-label classification, Decision Trees: ID3, Classification and Regression Trees (CART), Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Support vector machines: Linear and Non- Linear, Kernel Functions, K-Nearest Neighbors |
| **Unit V:** 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 internalcomponent only, Not to be included in the External Examinationquestion 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 fromthis course | Knowledge, Problem Solving, Analytical ability, ProfessionalCompetency, 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, John Wiley and Sons.1. Han, J. and Kamber, M. (2006): Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publishers.
 |
| **Reference Books** | 1. Paolo Gludici (2003): Applied Data Mining: Statistical Methods for Business and Industry, John Wiley and 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, Prentice hall 2nd 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, Tata 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)

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.

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

**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**

****