# Department Of Statistics

## <B.SC STATISTICS >

### VISION

The department of Statistics aspires to establish and develop a nucleus of academic eminence and caliber in mathematical and applied Statistics through dynamic teaching, learning and collaborative research work thereby bringing out the best statisticians.

### MISSION

**Mission 1: Advancing Statistical Knowledge**: Conduct cutting-edge research to develop new statistical methodologies and improve existing techniques, contributing to the field's theoretical and practical advancements.
**Mission 2: Providing High-Quality Education**: Offer comprehensive undergraduate and graduate programs to train students in statistical theory, methods, and applications, preparing them for careers in academics, industry, and government sectors.
**Mission 3: Promoting Interdisciplinary Collaboration**: Foster partnerships with other academic departments, research institutions, and industry to apply statistical methods to a wide range of disciplines, enhancing the impact and relevance of statistical science.
**Mission 4: Engaging in Community Outreach**: Serve the broader community by providing statistical consulting services, organizing workshops and seminars, and promoting statistical literacy among the public.

### PROGRAMME EDUCATIONAL OBJECTIVES:

**PEO 1: Professional Excellence and Higher Education**
Graduates will possess strong foundational knowledge in Statistics and related disciplines to serve effectively in industry, academia, and society, and will be competent to pursue higher studies and research.
**PEO 2: Technical Proficiency and Analytical Capability**
Graduates will acquire proficiency in programming languages such as C++, R, and other emerging analytical tools, enabling them to excel in data analytics, pharmaceutical research, and various corporate sectors.
**PEO 3: Lifelong Learning, Communication, and Ethics**
Graduates will adapt to technological advancements through continuous learning, develop effective communication and interpersonal skills, and uphold professional ethics and social responsibility in their careers.

### PROGRAM SPECIFIC OUTCOME (PSOs)

**PSO 1: Statistical Knowledge and Analytical Proficiency**
Demonstrate comprehensive knowledge of statistical concepts, theories, and methodologies including probability, inference, sampling, time series, and multivariate analysis to interpret and analyze real-world data effectively.
**PSO 2: Application and Decision-Making Skills**

Apply appropriate statistical tools, models, and computational techniques to transform information, analyze data, and make evidence-based and rational decisions across diverse fields.

**PSO 3: Professional Competence and Lifelong Learning**

Develop problem-solving ability, research aptitude, communication skills, and ethical awareness to pursue successful careers and higher studies in national and international academic, government, and industrial sectors.

## PROGRAMME OUTCOMES:

**PO 1: Foundational Knowledge:**

Recall fundamental concepts, theories, and principles of statistics and mathematics essential for understanding and solving quantitative problems.

**PO 2: Conceptual Understanding:**

Interpret statistical ideas, models, and methods to comprehend data behavior and explain real-life phenomena.

**PO 3: Practical Application:**

Apply appropriate statistical techniques, software tools, and analytical skills to solve practical and research-based problems.

**PO 4: Analytical Ability:**

Analyze data sets, identify trends and relationships, and draw meaningful inferences to support decision-making.

**PO 5: Critical Evaluation:**

Evaluate statistical models, methodologies, and outcomes based on accuracy, reliability, ethics, and societal impact.

**PO 6: Innovation and Creation:**

Create innovative statistical models, research designs, and computational frameworks to address complex real-world issues.

**PO 7: Teamwork and Communication:**

Demonstrate teamwork, leadership, and communication skills in multidisciplinary environments for effective project execution.

**PO 8: Lifelong Learning and Professional Growth:**

Develop a lifelong learning attitude to adapt, innovate, and contribute to advancements in statistics and data science.

## Credit Definition

| Type | Duration (in hours) | Credit |
|---|---|---|
| Lecture (L) | 1 | 1 |
| Tutorial (T) | 1 | 1 |
| Practical (P) | 2 | 1 |

## Total Credit Distribution for the Entire Programme

| Semester | Credits | | | | | | | | | Credits/ Semester |
|---|---|---|---|---|---|---|---|---|---|---|
| | MC | NON-MAJOR | | MDC | AEC | SEC | VAC | INT | Project | |
| | | NM | NV | | | | | | | |
| I | 8 | 4 | 1+1 | - | 2 | 3 | 2 | - | - | 21 |
| II | 8 | - | 1+1 | 3 | 2 | 3 | 2 | - | - | 20 |
| III | 9 | 4 | 1+1 | 3 | 2 | - | - | - | - | 20 |
| IV | 9 | 4 | 1+1 | 3 | 2 | - | - | - | - | 20 |
| V | 13 | - | 1+1 | - | - | 3 | 2 | - | - | 20 |
| VI | 12 | 4 | 1+1 | - | - | - | - | 3 | - | 21 |
| VII | 12 | 4 | | - | - | - | - | - | 4 | 20 |
| VIII | 12 / 16 | - | - | - | - | - | - | - | 8 / 4 | 20 |
| Credits / Course | 83/ 87 | 32 | | 9 | 8 | 9 | 6 | 3 | 12 / 8 | - |
| Total Credit | | | | | | | | | | 162 |

## Category Definition

| Definition of Category/Type | Abbreviation |
|---|---|
| Major Courses | **MC** |
| Non-Major Minor | **NM** |
| Non-Major Vocational | **NV** |
| Multidisciplinary Courses | **MDC** |
| Ability Enhancement Courses | **AEC** |
| Skill Enhancement Courses | **SEC** |
| Value Added Courses | **VAC** |
| Internship | **INT** |

## FIRST YEAR

### SEMESTER-I

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Descriptive Statistics I | STATU011T01 | MC1 | 3 | 3 | 0 | 0 |
| 2 | Descriptive Statistics I LAB | STATU011P02 | | 1 | 0 | 0 | 2 |
| 3 | Probability I | STATU011T03 | MC2 | 4 | 4 | 0 | 0 |
| 4 | Real Analysis | | NM1 | 4 | 4 | 0 | 0 |
| 5 | Vocational – EAA I (Yoga/ Sports/ NCC/ NSS) | | NV1 | 1 | 0 | 0 | 2 |
| 6 | Vocational – Soft Skill Development I | | NV2 | 1 | 1 | 0 | 0 |
| 7 | Communicative English I | | AEC1 | 2 | 2 | 0 | 0 |
| 8 | Environmental Science I | | VAC1 | 2 | 2 | 0 | 0 |
| 9 | Computer Application | | SEC1 | 3 | 3 | 0 | 0 |
| **Total Credit = 21** | | | | | | | |

### SEMESTER-II

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Linear Algebra | STATU111T01 | MC3 | 3 | 3 | 0 | 0 |
| 2 | Linear Algebra LAB | STATU111P02 | | 1 | 0 | 0 | 2 |
| 3 | Probability II | STATU111T03 | MC4 | 3 | 3 | 0 | 0 |
| 4 | Probability II LAB | STATU111P04 | | 1 | 0 | 0 | 2 |
| 5 | Vocational – EAA I (Yoga/ Sports/ NCC/ NSS ) | | NV3 | 1 | 0 | 0 | 2 |
| 6 | Vocational – Soft Skill Development II | | NV4 | 1 | 1 | 0 | 0 |
| 7 | Selected by the candidate (Elective) | | MDC1 | 3 | 3 | 0 | 0 |
| 8 | Communicative English II | | AEC2 | 2 | 2 | 0 | 0 |
| 9 | Environmental Science II | | VAC2 | 2 | 2 | 0 | 0 |
| 10 | Basic Management Skill | | SEC2 | 3 | 3 | 0 | 0 |
| **Total Credit = 20** | | | | | | | |

## SECOND YEAR

### SEMESTER-III

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Descriptive Statistics II | STATU211T01 | MC5 | 3 | 3 | 0 | 0 |
| 2 | Descriptive Statistics II LAB | STATU211P02 | | 1 | 0 | 0 | 2 |
| 3 | Sampling Distributions | STATU211T03 | MC6 | 5 | 5 | 0 | 0 |
| 4 | XXXXX | | NM2 | 3 | 3 | 0 | 0 |
| 5 | XXXXX | | | 1 | 0 | 0 | 2 |
| 6 | Vocational – Mentored Seminar I | | NV5 | 1 | 0 | 0 | 2 |
| 7 | Vocational – Soft Skill Development III | | NV6 | 1 | 1 | 0 | 0 |
| 8 | Selected by the candidate (Elective) | | MDC2 | 3 | 3 | 0 | 0 |
| 9 | Logical Ability I / Foreign Language I | | AEC3 | 2 | 2 | 0 | 0 |
| **Total Credit = 20** | | | | | | | |

### SEMESTER-IV

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Statistical Inference I | | MC7 | 3 | 3 | 0 | 0 |
| 2 | Statistical Inference I LAB | | | 1 | 0 | 0 | 2 |
| 3 | Economic Statistics | | MC8 | 4 | 4 | 0 | 0 |
| 4 | Economic Statistics LAB | | | 1 | 0 | 0 | 2 |
| 5 | XXXXX | | NM3 | 3 | 3 | 0 | 0 |
| 6 | XXXXX | | | 1 | 0 | 0 | 2 |
| 7 | Vocational – Mentored Seminar I | | NV7 | 1 | 0 | 0 | 2 |
| 8 | Vocational – Soft Skill Development IV | | NV8 | 1 | 1 | 0 | 0 |
| 9 | Selected by the candidate (Elective) | | MDC3 | 3 | 3 | 0 | 0 |
| 10 | Logical Ability II / Foreign Language II | | AEC4 | 2 | 2 | 0 | 0 |
| **Total Credit = 20** | | | | | | | |

## THIRD YEAR

### SEMESTER-V

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Statistical Inference II | | MC9 | 3 | 3 | 0 | 0 |
| 2 | Statistical Inference II LAB | | | 1 | 0 | 0 | 2 |
| 3 | Linear Models | | MC10 | 3 | 3 | 0 | 0 |
| 4 | Linear Models LAB | | | 1 | 0 | 0 | 2 |
| 5 | Numerical Analysis Using C++ | | MC11 | 3 | 3 | 0 | 0 |
| 6 | Numerical Analysis Using C++ LAB | | | 2 | 0 | 0 | 4 |
| 7 | Vocational – Mentored Seminar I | | NV9 | 1 | 0 | 0 | 2 |
| 8 | Vocational – Soft Skill Development V | | NV10 | 1 | 1 | 0 | 0 |
| 9 | Data Analysis | | SEC3 | 3 | 3 | 0 | 0 |
| 10 | Ethics Study and IPR | | VAC3 | 2 | 2 | 0 | 0 |
| **Total Credit = 20** | | | | | | | |

### SEMESTER-VI

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Design of Experiments | | MC12 | 3 | 3 | 0 | 0 |
| 2 | Design of Experiments LAB | | | 1 | 0 | 0 | 2 |
| 3 | Survey Sampling | | MC13 | 3 | 3 | 0 | 0 |
| 4 | Survey Sampling LAB | | | 1 | 0 | 0 | 2 |
| 5 | Statistical Computing Using R | | MC14 | 3 | 3 | 0 | 0 |
| 6 | Statistical Computing Using R LAB | | | 1 | 0 | 0 | 2 |
| 7 | XXXXX | | NM4 | 3 | 3 | 0 | 0 |
| 8 | XXXXX | | | 1 | 0 | 0 | 2 |
| 9 | Vocational – Mentored Seminar I | | NV11 | 1 | 0 | 0 | 2 |
| 10 | Vocational – Soft Skill Development VI | | M14 | 1 | 1 | 0 | 0 |
| 11 | Internship | | INT1 | 3 | 0 | 0 | 6 |
| **Total Credit = 21** | | | | | | | |

## FOURTH YEAR

### SEMESTER-VII

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Statistical Inference III | | MC15 | 3 | 3 | 0 | 0 |
| 2 | Statistical Inference III LAB | | | 1 | 0 | 0 | 2 |
| 3 | Regression Analysis | | MC16 | 3 | 3 | 0 | 0 |
| 4 | Regression Analysis LAB | | | 1 | 0 | 0 | 2 |
| 5 | Statistical Quality Control | | MC17 | 3 | 3 | 0 | 0 |
| 6 | Statistical Quality Control LAB | | | 1 | 0 | 0 | 2 |
| 7 | Dissertation / Minor Project | | Project | 4 | 0 | 0 | 8 |
| 8 | XXXXX | | NM5 | 3 | 3 | 0 | 0 |
| 9 | XXXXX | | | 1 | 0 | 0 | 2 |
| **Total Credit = 20** | | | | | | | |

### SEMESTER-VIII

| Sl No | Course Name | Code | Type | Credit | Teaching Scheme | | |
|---|---|---|---|---|---|---|---|
| | | | | | L | T | P |
| 1 | Multivariate Analysis | | MC18 | 3 | 3 | 0 | 0 |
| 2 | Multivariate Analysis LAB | | | 1 | 0 | 0 | 2 |
| 3 | Discrete Data Analysis | | MC19 | 3 | 3 | 0 | 0 |
| 4 | Discrete Data Analysis LAB | | | 1 | 0 | 0 | 2 |
| 5 | Demography and Survival Analysis | | MC20 | 3 | 3 | 0 | 0 |
| 6 | Demography and Survival Analysis LAB | | | 1 | 0 | 0 | 2 |
| 7 | Dissertation/(Operations Research+ Final Project / Seminar) | | Project/ Courses | 8/ (4+4) | 0/ (3+0) | 0 | 16/ (2+8) |
| **Total Credit = 20** | | | | | | | |

## COURSE CO-PO-PSO MAPPING

## SEMESTER-I

### Descriptive Statistics I

**COURSE OUTCOMES:**

**CO1: Discuss** about different kinds of data, where they come from, how they are represented, the basic statistical measurements of univariate and bivariate data.
**CO2: Illustrate** how to use statistical concepts that are suited for collection, representation, measurement and analysis of univariate and bivariate datasets.
**CO3: Differentiate** among data types, graphical representations and statistical indicators to analyze the structure and characteristics of both univariate and bivariate data.
**CO4: Select** graphical outputs as well as statistical summaries to identify trends, patterns or anomalies in univariate and bivariate data.
**CO5: Construct** a thorough statistical analysis by compiling unprocessed data from several sources, displaying it visually and calculating important univariate and bivariate statistics.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

### Descriptive Statistics I LAB

**COURSE OUTCOMES:**

**CO1: Recall and organize** different types of data and present them using frequency distributions and appropriate graphical techniques.
**CO2: Apply** computational methods to determine measures of central tendency and dispersion for univariate data.
**CO3: Analyze** data using moments, skewness, kurtosis, and quantiles to understand data distribution characteristics.
**CO4: Evaluate and interpret** bivariate data using covariance and correlation methods including rank correlation.
**CO5: Construct** comprehensive data summaries and visualizations integrating univariate and bivariate analyses for meaningful conclusions.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Probability I

**COURSE OUTCOMES:**

**CO1: Explain** the basic concepts of probability and its foundational definitions.

**CO2: Solve** numerical problems using the knowledge of conditional probability and its related theorems.

**CO3: Differentiate** between one dimensional discrete and continuous random variables based on their probability distributions and moments.

**CO4: Judge** the applicability of different probability inequalities in bounding the likelihood of certain events.

**CO5: Construct** various generating functions to model and analyze properties of random variables in probabilistic systems.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## SEMESTER-II

## Linear Algebra

### COURSE OUTCOMES:

**CO1: Recall** fundamental concepts of vectors, vector spaces, matrices, and determinants and their interrelationships.
**CO2: Apply** vector and matrix operations to solve systems of linear equations and represent linear transformations effectively.
**CO3: Analyze** the dependence, independence, and dimensional relationships among subspaces and matrix ranks to interpret consistency of linear systems.
**CO4:** Evaluate eigenvalues, eigenvectors, and quadratic forms to assess matrix properties and problem structures.
**CO5: Develop** optimized mathematical models and algorithms using orthogonalization, diagonalization, and quadratic reduction techniques.

### MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |
| CO4 | 1 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Linear Algebra LAB

### COURSE OUTCOMES:

**CO1: Recall and explain** computational methods for vectors, matrices, determinants, and their role in solving linear systems.
**CO2: Apply** concepts of subspaces, orthogonalization, and rank determination to practical numerical problems using matrix methods.
**CO3: Analyze** linear dependencies, consistency, and orthogonal relations through computational experiments.
**CO4: Evaluate** correctness and efficiency of computational procedures in eigenvalue and quadratic form analysis.
**CO5: Design** algorithmic workflows integrating orthogonalization, diagonalization, and quadratic form computation to real-world applications.

## MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Probability II

**COURSE OUTCOMES:**

**CO1: Explain** the concepts of different standard discrete probability distributions with their properties and applications.

**CO2: Apply** the concepts of different standard continuous probability distributions with their properties and applications.

**CO3: Differentiate** between discrete and continuous probability distributions by examining their limiting and truncated forms and applications to real-world random phenomena.

**CO4: Assess** the relationship between two-dimensional random variables using joint, marginal, and conditional distributions and **evaluate** their different characteristics.

**CO5: Formulate** probability models based on Trinomial and Bivariate Normal distributions to represent and predict multivariate random behavior.

## MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Probability II LAB

**COURSE OUTCOMES:**

**CO1*:* Describe** the procedure of solving numerical problems based on fitting of different standard discrete probability distributions.

**CO2*:* Demonstrate** the technique of solving applications based on different standard discrete probability distributions.

**CO3*:* Explain** the procedure of solving numerical problems based on fitting and application of Normal distribution.

**CO4*:* Interpret** the findings from other standard continuous probability distributions by solving its problems.

**CO5*:* Develop** the knowledge of Trinomial and Bivariate Normal distributions for solving its problems.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
| CO1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 1 |
| CO3 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 1 |
| CO4 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 1 |
| CO5 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 1 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**SEMESTER-III**

**Descriptive Statistics II**

**COURSE OUTCOMES:**

**CO1: Discuss** key concepts of bivariate data analysis, categorical data analysis and multivariate data analysis.
**CO2: Execute** regression, association measures and appropriate multivariate techniques on relevant datasets.
**CO3: Differentiate** among various statistical measures used in analyzing categorical and multivariate data.
**CO4: Judge** the suitability and effectiveness of different statistical techniques for analyzing bivariate, categorical, and multivariate data.
**CO5: Design** statistical models using advanced multivariate techniques to address complex data analysis problems.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**Descriptive Statistics II LAB**

**COURSE OUTCOMES:**

**CO1: Explain** the concepts of bivariate, categorical, and multivariate data and their interrelations using appropriate datasets.
**CO2: Apply** statistical tools such as correlation ratio, intra-class correlation, and multiple correlation in real-life data analysis.
**CO3: Differentiate** between various association measures and regression models for analyzing categorical and multivariate data.
**CO4: Evaluate** the suitability of multivariate techniques for analyzing relationships among multiple variables.
**CO5: Construct and incorporate** the idea of multivariate models and matrices (mean vector, dispersion matrix) for complex data analysis.

## MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Sampling Distributions

**COURSE OUTCOMES:**

**CO1**: **Describe** the foundational ideas of sampling and methods to derive sampling distributions of a statistic.

**CO2**: **Use** the properties of exact sampling distributions to solve problems and draw statistical conclusions.

**CO3**: **Examine** the structural differences and interconnections among the exact sampling distributions with respect to their derivations and behavior.

**CO4**: **Critique** the sampling distributions of key statistics obtained from a Bivariate Normal population in terms of their validity and theoretical implications.

**CO5**: **Formulate** models based on order statistics to interpret positional characteristics and range within sample data.

## MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## SEMESTER-IV

## Statistical Inference I

**COURSE OUTCOMES:**

**CO1: Explain** the fundamental concepts of statistical inference, including population, parameter, sampling distribution and standard error, and **recall** different methods of statistical inference.
**CO2: Apply** the principles of point estimation to derive and evaluate estimators using properties such as unbiasedness, efficiency, and sufficiency, and explain related theorems like Rao-Blackwell and Lehmann–Scheffé.
**CO3: Employ** various methods of estimation like Method of Moments, Least Squares, Maximum Likelihood, and Minimum Chi-Square to estimate parameters of standard distributions.
**CO4: Test** statistical hypotheses and **evaluate** probabilities of type I and type II errors, power and significance levels for tests involving different distributions.
**CO5: Incorporate** concepts of estimation and hypothesis testing to solve real-life statistical problems involving univariate, two independent and bivariate populations.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Statistical Inference I LAB

**COURSE OUTCOMES:**

**CO1: Review** the concepts of unbiasedness and efficiency to **identify** and **compare** different estimators based on their variances.
**CO2: Determine** sufficient statistics for various probability distributions using the Neyman–Fisher Factorization Theorem and verify their sufficiency properties.
**CO3: Identify** the Cramér–Rao Lower Bound (CRLB) to evaluate the efficiency of unbiased estimators in regular estimation problems.

**CO4: Determine** estimation techniques using Maximum Likelihood Estimation (MLE) and the Method of Moments for different probability models.
**CO5: Develop** solutions to hypothesis testing problems for univariate, bivariate, and two-sample problems, including computation of size, power, and power curves for various statistical tests.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Economic Statistics

**COURSE OUTCOMES:**
**CO1*:* Describe** the concepts of various index numbers with their uses.
**CO2*:* Illustrate** the concepts of the measurements of income inequality.
**CO3*:* Explain** the concepts of different components and models of a time series data.
**CO4*:* Estimate** the trend and seasonal components of a time series data using different methods.
**CO5*:* Incorporate** moving average and auto regressive processes for forecasting.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 2 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Economic Statistics LAB

**COURSE OUTCOMES:**

**CO1*:* Describe** the procedure for solving numerical problems based on computations of different index numbers along with their tests for consistency.

**CO2*:* Apply** the knowledge for solving numerical problems related to the measurement of income inequality.

**CO3*:* Investigate** the nature of time series data through different graphical representations in order to detect various features.

**CO4*:* Estimate** the trend and seasonal components of a time series data with the help of different computational methods.

**CO5*:* Formulate** moving average and auto regressive processes in forecasting a time series data.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**SEMESTER-V**

**Statistical Inference II**

**COURSE OUTCOMES:**

**CO1**: **Explain** the concepts of non-randomized and randomized tests, and distinguish between Most Powerful (MP), Uniformly Most Powerful (UMP), and Unbiased tests.
**CO2**: **Apply** the Neyman–Pearson lemma to construct Most Powerful and Uniformly Most Powerful tests for simple and composite hypotheses.
**CO3**: **Derive** and interpret Generalized Likelihood Ratio Tests (GLRTs) for one-sample, two-sample, and multi-sample problems under normal and selected non-normal populations.
**CO4**: **Determine** confidence intervals and confidence sets for parameters such as mean, variance, binomial proportion, and correlation coefficient using pivotal quantities.
**CO5**: **Revise** the relationship between confidence estimation and hypothesis testing, and summarize the properties of shortest-length, UMA, UMAU confidence sets.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**Statistical Inference II LAB**

**COURSE OUTCOMES:**

**CO1**: **Study** the use of the principles of Most Powerful (MP) and Uniformly Most Powerful (UMP) tests to solve problems on testing parameters of various distributions.
**CO2**: **Derive** Likelihood Ratio Tests (LRTs) for single univariate populations under normal and non-normal cases.
**CO3**: **Detect** and **infer** LRTs for comparing parameters of two independent univariate populations.

**CO4**: **Determine** confidence intervals for parameters of single and two-population models using pivotal quantities.
**CO5**: **Construct** shortest-length confidence intervals and evaluate their efficiency in estimation.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Linear Models

**COURSE OUTCOMES:**

**CO 1: Define** the fundamental concepts of linear models, regression, analysis of variance, and analysis of covariance, including their assumptions, terminologies, and theoretical foundations.
**CO 2: Compute** the interrelationships among linear estimation, regression analysis, ANOVA, and ANCOVA models, and describe how these statistical techniques contribute to data interpretation and hypothesis testing.
**CO 3: Analyze** the least squares estimation, regression modeling, and analysis of variance and covariance techniques to real and simulated data using appropriate statistical software.
**CO 4: Evaluate** the adequacy, efficiency, and validity of fitted statistical models by conducting hypothesis testing, diagnostic checking, and decomposition of variation.
**CO 5: Formulate** statistical models integrating regression, ANOVA, and ANCOVA principles, and effectively communicate analytical results with clarity, ethics, and professionalism.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Linear Models LAB

**COURSE OUTCOMES:**

**CO 1: Identify and recall** the fundamental principles of linear estimation, regression analysis, analysis of variance, and analysis of covariance through practical exercises using statistical tools.

**CO 2: Apply** the concepts of estimability, hypothesis testing, and interrelationship among regression, ANOVA, and ANCOVA models using appropriate examples and data.

**CO 3: Explain** regression, ANOVA, and ANCOVA techniques to analyze and interpret experimental data using scientific calculators, statistical tables, and MS Excel.

**CO 4: Evaluate** model adequacy, efficiency, and validity through diagnostic checking, analysis of residuals, and verification of underlying assumptions in regression and variance models.

**CO 5: Design and construct** statistical models integrating regression, ANOVA, and ANCOVA principles to draw meaningful inferences and present analytical conclusions effectively.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Numerical Analysis Using C++

**COURSE OUTCOMES:**

**CO1: Explain** the fundamental concepts of numerical approximation, interpolation, and basic programming structures to understand numerical problem-solving approaches.

**CO2: Apply** various numerical techniques to solve mathematical problems using computational tools.

**CO3: Analyze** the accuracy and convergence of numerical methods and algorithms used for solving equations and systems of equations.

**CO4: Assess** the knowledge about different decision-making statements and looping structures in a C environment.

**CO5: Develop** the concepts of using arrays and user defined functions while writing a C program.

**MAPPING OF Cos WITH Pos AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Numerical Analysis Using C++ LAB

**COURSE OUTCOMES:**

**CO1: Explain** and **elaborate** fundamental numerical and statistical operations using computational tools.

**CO2: Apply** numerical algorithms to solve one-variable and system-of-equation problems using iterative and matrix-based techniques.

**CO3: Analyze** univariate and bivariate data to compute and interpret descriptive statistical measures for ungrouped and grouped datasets using C programming.

**CO4: Evaluate** probabilistic models through fitting of distributions and random number generation techniques for simulation-based understanding using C programming.

**CO5: Design** computational workflows integrating numerical and statistical methods using C programming.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
| CO1 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO4 | 2 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO5 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## SEMESTER-VI

## Design of Experiments

**COURSE OUTCOMES:**

**CO 1: Define** the fundamental concepts, terminologies, and principles of design of experiments including basic, factorial, and advanced designs such as split and strip plots used in agricultural and industrial contexts.
**CO 2: Apply** the structure, layout, assumptions, and interpretation of various experimental designs including CRD, RBD, LSD, factorial, confounding, split and strip plot designs, highlighting their practical relevance and efficiency.
**CO 3: Explain** appropriate statistical techniques to plan, conduct, and analyze experiments using CRD, RBD, LSD, and factorial designs including handling missing data and interpretation of results.
**CO 4: Evaluate and compare** the efficiency, precision, and validity of different experimental designs such as RBD, LSD, and factorial experiments with total and partial confounding.
**CO 5: Design** advanced experimental layouts such as split plot and strip plot designs for solving real-life agricultural and industrial problems.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Design of Experiments LAB

**COURSE OUTCOMES:**

**CO 1: Identify** the fundamental principles, terminologies, and assumptions underlying CRD, RBD, LSD, factorial, and complex experimental designs.
**CO 2: Derive** the structure, randomization, and logic of various designs such as CRD, RBD, LSD, factorial, and confounded designs, and interpret their analytical procedures.
**CO 3: Explain** the suitable statistical methods for the analysis of data from different designs including missing observations, factorial structures, and confounded arrangements using scientific calculators or Excel.

**CO 4: Evaluate** the efficiency, precision, and interpretative validity of CRD, RBD, LSD, and factorial designs including complete and partial confounding and compare them.
**CO 5: Develop** advanced experimental setups such as Split Plot and Strip Plot designs for practical applications in agricultural and industrial research.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Survey Sampling

**COURSE OUTCOMES:**
**CO1: Explain** the introductory concepts related to survey sampling.
**CO2: Illustrate** the knowledge of Simple Random Sampling (SRS) and its applications.
**CO3: Outline** the concepts of Stratified Random Sampling (STRS) and its applications.
**CO4: Summarize** the knowledge of Systematic Sampling (SYS), Ratio and Regression methods of estimation and their applications in real-life scenarios.
**CO5: Incorporate** the concepts of Cluster and Two-stage Sampling to different situations.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 2 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Survey Sampling LAB

**COURSE OUTCOMES:**

**CO1: Identify** the procedures of solving numerical problems of Simple Random Sampling (SRS).

**CO2: Solve** numerical problems based on Stratified Random Sampling (STRS).

**CO3: Explain** the techniques to solve numerical problems related to Linear and Circular Systematic Sampling.

**CO4: Interpret** the findings after solving numerical problems related to Ratio & Regression methods of estimation.

**CO5: Develop** the procedures of solving numerical problems related to Cluster Sampling and Two-stage Sampling.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 1 |
| CO3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 1 |
| CO4 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 1 |
| CO5 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 1 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Statistical Computing Using R

**COURSE OUTCOMES:**

**CO1: Explain** the fundamentals of R programming and descriptive statistics for data visualization and summarization.

**CO2: Apply** R commands to compute descriptive measures, correlation, and regression, and generate graphical and automated statistical summaries.

**CO3: Analyze** datasets using random number generation, sampling, and curve fitting to identify suitable distributions and data patterns.

**CO4: Evaluate** results from regression, distribution fitting, and hypothesis testing using R outputs to ensure correctness and reliability.

**CO5: Design and incorporate** complete statistical analysis projects in R integrating data import, visualization, model fitting, and inference.

MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Statistical Computing Using R LAB

**COURSE OUTCOMES:**

**CO1: Clarify** the fundamental R programming operations, data types, control structures, and user-defined functions.

**CO2: Apply** matrix operations, array manipulations, and data extraction techniques for statistical problem solving in R.

**CO3: Analyze** datasets using descriptive statistics, correlation, regression, and curve fitting for effective data interpretation.

**CO4: Evaluate** the correctness and appropriateness of statistical tests including z, t, $\chi^2$, F, and ANOVA using R outputs.

**CO5: Integrate and incorporate** complete R-based statistical workflows integrating data visualization, modeling, and hypothesis testing.

MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 |
| CO5 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**SEMESTER-VII**

**Statistical Inference III**

**COURSE OUTCOMES:**

**CO1: Describe** what is meant by convergence in law, convergence in probability, convergence in mean and almost sure convergence for a given sequence of random variables.
**CO2: Apply** the concepts of WLLN, SLLN, CLT to a parametric estimation problem.
**CO3: Explain** the asymptotic notions of parametric inference like consistency, efficiency, CAN, BAN.
**CO4: Determine** the asymptotic distribution of different sample statistics for large samples and study related results.
**CO5: Develop** the large sample non-parametric testing methodologies for one and two sample cases.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO5 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**Statistical Inference III LAB**

**COURSE OUTCOMES:**

**CO1: Describe** non parametric tests and confidence interval estimation methodologies.
**CO2: Explain** the testing methodologies related to Pearsonian chi-square statistic.
**CO3: Apply** the sign test and Wilcoxon signed rank test to one sample data.
**CO4: Analyze** two sample data using Mann Whitney U statistic, Wilcoxon rank-sum test.
**CO5: Develop** testing methodologies for multi-sample data.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO5 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Regression Analysis

**COURSE OUTCOMES:**

**CO1: Recall** fundamental concepts, definitions, and steps of regression analysis, including simple and multiple linear regression models, properties of least square estimators, and basic hypothesis testing procedures.

**CO2: Calculate** the principles of regression diagnostics, detection of model violations (heteroscedasticity, autocorrelation, multicollinearity), influence measures, residual analysis, and techniques for working with collinear data.

**CO3: Construct the** regression techniques to analyze experimental or real-world data, perform residual analysis, and detect influential points using statistical software or calculators.

**CO4: Explain** the effects of departures from the Gauss-Markov assumptions, including heteroscedasticity, autocorrelation, and multicollinearity, and determine appropriate remedial measures.

**CO5: Design** regression models for collinear or correlated data using principal component regression and advanced estimation techniques to generate accurate and interpretable results.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Regression Analysis LAB

**COURSE OUTCOMES:**

**CO1: Recall** fundamental concepts and steps of regression analysis including simple and multiple regression models.

**CO2: Demonstrate** the idea standard regression model, residuals, and methods for detection of outliers and influential points.

**CO3: Analyse** the regression techniques, residual analysis, and graphical methods by using scientific calculators or R.

**CO4: Explain** departures from Gauss-Markov assumptions such as heteroscedasticity, autocorrelation, and multicollinearity and determine their impacts.

**CO5: Design** regression experiments incorporating remedies for model violations and construct interpretable models for given datasets.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Statistical Quality Control

**COURSE OUTCOMES:**

**CO1: Define** the underlying concepts of Statistical Quality Control and ISO quality standards.

**CO2: Classify** the problems of process control and product control.

**CO3: Select** appropriate variable and attribute control charts to comment on the state of control of a given production process.

**CO4: Compare** the usage of single and double sampling inspection plans for Attributes in terms of their different functions.

**CO5: Explain** the concepts of various Process Capability indices and Six-Sigma methodology.

MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 3 | 2 |

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## Statistical Quality Control LAB

**COURSE OUTCOMES:**

**CO1: Select** and **draw** appropriate variable control charts to comment on the state of control of a given production process.

**CO2: Construct** appropriate attribute control charts to comment on the state of control of a given production process.

**CO3: Examine** and **analyze** the nature of points plotted in different control charts to detect any shift from the state of control.

**CO4: Determine** the appropriate sampling inspection plan for a given problem.

**CO5: Construct** OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves for single and double sampling inspection plans.

MAPPING OF COs WITH POs AND PSOs:

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |

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**SEMESTER-VIII**

**Multivariate Analysis**

**COURSE OUTCOMES:**

**CO1: Study** the basic concepts of multivariate probability distributions, marginal and joint distributions, conditional distributions.
**CO2: Describe** the methodologies of multivariate regression and its uses with real-life data.
**CO3: Determine** multivariate distributions in both discrete and continuous cases and perform related hypothesis tests.
**CO4: Analyze** high dimensional data using principal component analysis.
**CO5: Develop** the knowledge of applying Factor Analysis to high dimensional data.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

**Multivariate Analysis LAB**

**COURSE OUTCOMES:**

**CO1: Enumerate** joint and conditional distribution functions for random vectors.
**CO2: Predict** response variables using multivariate regression models.
**CO3: Apply** multinomial and multivariate normal distributions to real-life data.
**CO4: Diagnose** challenges with high dimensional data and learn the uses of PCA.
**CO5: Model** multivariate data using factors and apply appropriate inferential methods.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |
| CO5 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |

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## Discrete Data Analysis

**COURSE OUTCOMES:**

**CO1: Explain** the types of categorical data, study designs, and measures of association used in categorical data analysis.
**CO2: Apply** the concepts of Generalized Linear Models (GLMs) to model different forms of categorical and count data using appropriate link functions.
**CO3: Analyze** datasets by identifying the appropriate GLM components, link functions, and probability structures to interpret model behavior and fit.
**CO4: Evaluate** model adequacy, overdispersion, and fitting approaches such as quasi-likelihood and zero-inflated models to handle real-life discrete data problems.
**CO5: Design and incorporate** a complete categorical data analysis framework by selecting suitable models, estimating parameters using MLE, and interpreting results for complex datasets.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

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## Discrete Data Analysis LAB

**COURSE OUTCOMES:**

**CO1: Explain** the concepts of association, concordance, and discordance for dichotomous and categorical data.
**CO2: Apply and derive** measures of association to evaluate relationships between categorical variables.
**CO3: Analyze** datasets using Generalized Linear Models (GLM) and identify suitable link functions for model fitting.

**CO4: Evaluate** the goodness of fit and parameter significance in Logistic, Log-linear, and Probit regression models.
**CO5: Design and incorporate** a complete categorical data modelling framework using GLM approaches in statistical software.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 3 |

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## Demography and Survival Analysis

**COURSE OUTCOMES:**

**CO1: Describe** the introductory concepts of vital statistics and measurements of mortality.
**CO2: Demonstrate** knowledge about the description and construction of life tables.
**CO3: Compare** the different measures of fertility and population growth.
**CO4: Explain** the concepts of different survival distributions and their applications.
**CO5: Outline** the different censoring schemes along with real-life examples and the basic concepts of competing risk theory.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Demography and Survival Analysis LAB

**COURSE OUTCOMES:**

**CO1: Discuss** the procedure of solving numerical problems relating to different mortality rates.
**CO2: Provide** solutions relating to numerical problems based on construction of life tables.
**CO3: Illustrate** the calculation procedures relating to the measurement of fertility and population growth.
**CO4: Estimate** the survival function, death density function and hazard function corresponding to different survival distributions.
**CO5: Formulate** the mean survival time and variance of the estimator for different censoring schemes and numerical problems based on the estimation of survival function and variance of the estimator using non-parametric methodologies.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |

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## Operations Research

**COURSE OUTCOMES:**

**CO1: Define** the fundamental concepts, scope, and models of Operations Research, and recognize decision-making environments under certainty, uncertainty, and risk.
**CO2: Apply** mathematical formulations to solve Linear Programming Problems, including duality, transportation, assignment, and traveling salesman problems.
**CO3: Analyze** strategic interactions in competitive environments using Game Theory concepts and apply graphical and dominance methods to find optimal strategies.
**CO4: Evaluate** inventory control models and their assumptions to determine optimal order quantities, perform sensitivity analysis, and interpret managerial implications.
**CO5: Construct** queuing and inventory models for real-world systems, interpret their performance measures, and propose improvements for efficiency.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| CO4 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 |
| CO5 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |

1. LOW 2. MODERATE 3. SUBSTANTIAL

## Operations Research LAB

**COURSE OUTCOMES:**

**CO1: Elaborate** the fundamental concepts and mathematical formulations of Operations Research through practical problem-solving.

**CO2: Apply** graphical and simplex methods to obtain optimal solutions for linear programming problems using real or simulated data.

**CO3: Analyze** duality, Big M, and Two-Phase methods to handle complex constraints and special linear programming problems.

**CO4: Evaluate and compare** solutions of transportation, assignment, inventory, and queuing models for operational efficiency.

**CO5: Create and integrate** game-theoretic models and optimization-based decision strategies for real-life decision-making problems.

**MAPPING OF COs WITH POs AND PSOs:**

| COURSE OUTCOMES | PROGRAMME OUTCOMES | | | | | | | | PROGRAMME SPECIFIC OUTCOMES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |

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