LEARNING OUTCOME BASED CURRICULUM FRAMEWORK (LOCF) FOR UNDERGRADUATE PROGRAMS

`````

## Department of Statistics



## LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

## PREFACE

Statistics is a discipline concerned with Collecting, Condensing, Analysing, and Drawing Inferences from Data for the purpose of providing intelligent and evidence-based solutions to issues concerning any human endeavour. Owing to its all-pervasive nature and applicability to almost all domains of knowledge, the presence of Statisticians is much required in any sector. The big-data boom has drawn the attention of youngsters who are finding statistics and the related area of data science as attractive choices for a rewarding career.

The learning outcome-based curriculum framework for a B.Sc. degree in Statistics is designed to prepare students in three important dimensions – Statistical Methodologies, requisite Mathematical Foundation and the much-needed Computing skills – and prepares them for an exciting career. This focus enables the students to experience and enjoy the three-year program and get ready for a great future as analysts and data-scientists in their chosen sectors. Students get exposure to applications of Statistics in related fields like actuarial, clinical and industrial statistics and get equipped with skills to handle big data in an information technology enabled environment.

The learning outcome-based curriculum framework provides the much-needed disciplinary knowledge, encourages self-learning, creates ethical consciousness, inculcates team spirit and empowers students with professional skills.

The curriculum, teaching pedagogy and assessment methods are designed to reach appropriate cognitive levels as per BLOOM's Taxonomy. The OBE based evaluation methods will pave way for the assessment of cognitive levels of the students and evaluate the expected course outcome attainment

The multi-pronged approach, which is being followed in the Statistics Department of Loyola College, enables the students pursuing a degree in Statistics to contribute to scientific advancement, industrial growth and national development through the skills that they acquire in the course of the three-year program.

# CONTENTS

# VISION, MISSION AND CORE VALUES OF LOYOLA COLLEGE

**VISION:**

- Towards holistic formation of youth, grounded in excellence, through accompaniment to serve the humanity

**MISSION:**

- To provide inclusive education through an integral and holistic formative pedagogy
- To promote skills that prepare them for the future
- To kindle in young minds the spirit of social and environmental justice with a blend of academic excellence and empathy
- To stimulate critical and conscientious scholarship leading to meaningful and innovative human capital

**CORE VALUES:**

- Cura Personalis
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering Solidarity
- Global Vision
- Spiritual Quotient

# VISION AND MISSION OF THE DEPARTMENT OF STATISTICS

**VISION:**

- To form credible statisticians with innovative skills to aid scientific decision-making.

**MISSION:**

- To educate students with the all-pervasive and all-inclusive nature of Statistics
- To equip students with techniques needed for handling issues in different spheres of human activity
- To empower students with theoretical, applied and computing skills required for a rewarding professional life

# PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

## (School of Computational Sciences)

| | |
|---|---|
| **PEO 1** | **Learning Environment And Life Long Learning**<br><br>To access academic facilities in an environment of inclusiveness and inquisitiveness for effective and immersed learning throughout life to attain excellence in the chosen field of computational sciences. |
| **PEO 2** | **Globally Relevant Curriculum And Scientific Temperament**<br><br>To think innovatively, analyze scientifically and take decisions appropriately, for handling contemporary global concerns through the knowledge earned in the computational sciences curriculum. |
| **PEO 3** | **Academic Excellence And Core Competency**<br><br>To excel in modern computational techniques and compete in higher studies/career, for addressing contemporary challenging problems with ease. |
| **PEO 4** | **Skill Development And Entrepreneurship**<br><br>To develop analytical, logical and critical problem-solving skills for executing professional work and become experts/entrepreneurs in the field of computational sciences. |
| **PEO 5** | **Environment And Sustainability**<br><br>To identify real world problems concerning environment and other issues; and apply the expertise in the computational sciences, to face the challenges and provide sustainable solutions. |
| **PEO 6** | **Professionalism And Ethics With Social Responsibility**<br><br>To equip themselves with the necessary competency towards professionalism in the computational sciences maintaining ethical standards in addressing the needs of industry and society. |

# PROGRAMME OUTCOMES (PO's)

## (School of Computational Sciences)

| | |
|---|---|
| **PO1** | **Disciplinary Knowledge & Information-Digital Literacy**<br><br>To acquire literacy in the respective discipline of computational sciences and demonstrate scholarly knowledge in the information-digital era. |
| **PO2** | **Self Directed and Life-Long Learning**<br><br>To adapt oneself to technological advancements in computing and engage in life-long self-learning for personal development in the context of inter-disciplinary nature of future endeavors. |
| **PO3** | **Sustainable Social and Environmental Consciousness**<br><br>To realize social and environmental problems and contribute the computational expertise to face the challenges and provide sustainable solutions. |
| **PO4** | **Critical Thinking: Analytical Reasoning & Problem Solving**<br><br>To critically reason out, analyze and develop solutions through various computational techniques for real time problems. |
| **PO5** | **Reasoning and Communication Skills**<br><br>To apply scientific reasoning in the approach to handle professional matters, communicate the solutions to stake holders and enable them to understand and appreciate the outcomes. |
| **PO6** | **Professionalism; Team Work And Ethics**<br><br>To manifest the core competencies, adhere to collaborative efforts within ethical frameworks and emerge as professionals holding key positions in the respective domains. |
| **PO7** | **Skill Development For Leadership And Entrepreneurship**<br><br>To construct togetherness with people by building professional skills and provide effective leadership progressing to become experts/entrepreneurs in the field of computational sciences |

# PROGRAMME SPECIFC OUTCOMES (PSO's)

## Department of Statistics

| | |
|---|---|
| **PSO 1** | **Disciplinary Knowledge & Digital Literacy**<br><br>To excel in organizing surveys, condensing data, estimating and testing hypotheses on the characteristics of a large population, designing statistical experiments, constructing models and bringing out the most useful information using statistical software packages |
| **PSO 2** | **Self Directed and Life-Long Learning**<br><br>To get self-motivated and well-prepared for a challenging career path in statistics through execution of application-oriented projects by self-learning in a competitive environment |
| **PSO 3** | **Sustainable Social And Environmental Consciousness**<br><br>To become conscious about social and environmental concerns by collecting relevant data and analyzing the same to provide suitable solutions |
| **PSO 4** | **Critical Thinking; Analytical Reasoning & Problem Solving**<br><br>To critically analyze real-time problems in all walks of life using statistical techniques to arrive at tangible solutions |
| **PSO 5** | **Scientific Reasoning and Communication Skills**<br><br>To handle professional matters scientifically by drawing support from statistical analysis of data and present a convincing report to stakeholders |
| **PSO 6** | **Professionalism, Team Work And Ethics**<br><br>To exhibit / showcase competency in applying statistical theory and methods with ethical principles in a collective endeavour |
| **PSO 7** | **Skill Development For Leadership and Entrepreneurship**<br><br>To get equipped with necessary tools and techniques of statistics towards developing oneself as leading professional / entrepreneur |

# B.Sc. Statistics Restructured CBCS Curriculum effective from June, 2019

| PART | SEMESTER 1 | SEMESTER 2 | SEMESTER 3 | SEMESTER 4 | SEMESTER 5 | SEMESTER 6 | CREDITS |
|---|---|---|---|---|---|---|---|
| I | General Language (3h/3c) | General Language (3h/3c) | General Language (3h/3c) | General Language (3h/3c) | ------- | ------- | 12 |
| II | General English (6h/3c) | General English (6h/3c) | General English (5h/3c) | General English (5h/3c) | ------- | ------- | 12 |
| III (MC) | Probability & Discrete Distributions (6h/6c) | Applied Statistics (6h/6c) | Matrix and Linear Algebra (6h/6c) | Estimation Theory (6h/6c) | Testing of Hypothesis (6h/6c) | Design of Experiments (6h/6c) | 84 |
| III (MC) | | | | | Stochastic Processes (6h/6c) | Operation Research (6h/6c) | 84 |
| III (MC) | Probability & Discrete Distributions (6h/6c) | Continuous Distributions (6h/6c) | Sampling Theory (6h/6c) | | Regression Analysis (6h/6c) | Statistical Quality Control (6h/6c) | 84 |
| III (MC) | | | | | Bio-Statistics & Survival Analysis (6h/6c) | | 84 |
| AR / AO | Mathematics for Statistics I (6h/3c) | Business Processes Management (6h/3c) | Numerical Mathematics with C (5h/3c) OR Basic Accounting (5h/3c) | Mathematics for Statistics - II (5h/3c) OR Structured Query Language (5h/3c) | | | 12 |
| ME | | | | Data Mining (6h/6c) OR Actuarial Statistics (6h/6c) | Data analysis using MS-Excel & SPSS (6h/6c) OR R Programming (6h/6c) | | 12 |
| MS | | | | | | Internship (100h/ 3c) Python (6h/6c) Project (6h/6c) | 15 |
| BT/AT/NME | | | NME (3h/2c) | NME (3h/2c) | MOOC/SSP | | 4 |
| FC | Foundation Course (3h/1c) | Foundation Course (3h/2c) | Foundation Course (2h/1c) | Foundation Course (2h/1c) | | | 5 |
| CCA | Co-curricular | Co-curricular (90h/1c) | | | | | 1 |
| ORA | | | Outreach | Outreach (120h/ 2c) | | | 2 |
| Total Hrs / C | 30h / 22c | 30h / 23c (+1c) | 30 h / 24c | 30 h / 24c (+2 c) | 30 h / 30 c | 30 h / 33 c | 180h/159c |

# LOYOLA COLLEGE (AUTONOMOUS), CHENNAI

## DEPARTMENT OF STATISTICS

### (2019 – Restructured Curriculum)

### B.Sc. STATISTICS – OVERALL COURSE STRUCTURE

| Sem. | Sub. Code | Course Title | T/L/P | Category* | Credit | Hours |
|------|-----------|--------------|-------|-----------|--------|-------|
| I | UTL 1101<br>UFR 1101<br>UOL 1101<br>UOL 1104 | General Tamil-I<br>French for Beginners – I<br>Hindi Prose –I<br>General Sanskrit-I | T | GL | 3 | 3 |
| I | UEL 1201<br>UEL 1202<br>UEL 1203 | General English- I (Advanced)<br>General English- I (Intermediate)<br>General English- I (Basic) | T | GE | 3 | 6 |
| I | UST 1501 | Statistical Methods | T | MC | 6 | 6 |
| I | UST 1502 | Probability & Discrete Distributions | T | MC | 6 | 6 |
| I | UMT 1303 | Mathematics for Statistics | T | AR | 3 | 6 |
| I | UHE 1001 | FC – Personality Development | T | FC | 1 | 3 |
| I | | Co-Curricular Activities | | CCA | | |
| | | | | | | |
| II | UTL 2101<br>UFR 2101<br>UOL 2101<br>UOL 2103 | General Tamil-II<br>French for Beginners - II<br>Hindi Prose -II<br>General Sanskrit-II | T | GL | 3 | 3 |
| II | UEL 2201<br>UEL 2202<br>UEL 2203 | General English- II (Advanced)<br>General English- II (Intermediate)<br>General English- II (Basic) | T | GE | 3 | 6 |
| II | UST 2501 | Continuous Distributions | T | MC | 6 | 6 |
| II | UST 2502 | Applied Statistics | T | MC | 6 | 6 |
| II | UCO 2301 | Business Process Management | T | AR | 3 | 6 |
| II | UHE 2001 | FC-Life issues and Coping Strategies | T | FC | 2 | 3 |
| II | | Co-Curricular Activities | | CCA | 1 | 90[&] |
| | | | | | | |
| III | UTL 3101<br>UFR 3101<br>UOL 3101<br>UOL 3102 | General Tamil-III<br>French for Beginners - III<br>Hindi Poetry -III<br>General Sanskrit-III | T | GL | 3 | 3 |
| III | UEL 3201<br>UEL 3202<br>UEL 3203 | General English- III (Advanced)<br>General English- III (Intermediate)<br>General English- III (Basic) | T | GE | 3 | 5 |
| III | UST 3501 | Sampling Theory | T | MC | 6 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| III | UST 3502 | Matrix & Linear Algebra | T | MC | 6 | 6 |
| III | UPH 3401 | Numerical methods and C++ programming | T | AO | 2 | 3 |
| | UPH 3402 | Numerical methods and C++ Programming – Lab | L | AO | 1 | 2 |
| | | [OR] | | | | |
| | UCO 3402 | Basic Accounting | T | AO | 3 | 5 |
| III | | BT / AT / NME | T | NME | 2 | 3 |
| III | UHE 3001 | FC – Social awareness | T | FC | 1 | 2 |
| III | | Outreach Activities | P | ORA | | |
| | | | | | | |
| IV | UTL 4101 | General Tamil-IV | T | GL | 3 | 3 |
| | UFR 4101 | French for Beginners - IV | | | | |
| | UOL 4101 | Hindi Poetry -IV | | | | |
| | UOL 4102 | General Sanskrit-IV | | | | |
| IV | UEL 4201 | Introduction to Technical Translation | T | GE | 3 | 5 |
| | UEL 4202 | Soft skills for Professional Development | | | | |
| | UEL 4203 | Professional Content Writing | | | | |
| | UEL 4204 | English for Technical Writing | | | | |
| | UEL 4205 | English for Employability Skills | | | | |
| | UEL 4206 | Essential skills for group Communication | | | | |
| | UEL 4207 | Theatre Performance and Film Review | | | | |
| IV | UST 4501 | Estimation Theory | T | MC | 6 | 6 |
| IV | UST 4601 | Actuarial Statistics [OR] | T | ME | 6 | 6 |
| | UST 4602 | Data Mining | T | ME | 6 | 6 |
| IV | UMT 4403 | Mathematics for Statistics – II [OR] | T | AO | 3 | 5 |
| | UST 4402 | Structured Query Lang | L | AO | 3 | 5 |
| IV | | BT / AT / NME | T | NME | 2 | 3 |
| IV | UHE 4001 | FC – Environmental Studies | T | FC | 1 | 2 |
| IV | | Outreach Activities | P | ORA | 2 | 120[&] |
| | | | | | | |
| V | UST 5501 | Applied Stochastic Processes | T | MC | 6 | 6 |
| V | UST 5502 | Biostatistics & Survival Analysis | T | MC | 6 | 6 |
| V | UST 5503 | Regression Analysis | T | MC | 6 | 6 |
| V | UST 5504 | Testing of Hypothesis | T | MC | 6 | 6 |
| V | UST 5601 | Data analysis using MS Excel & SPSS [or] | L | ME | 6 | 6 |
| | UST 5602 | R Language | L | ME | 6 | 6 |
| | | | | | | |
| VI | UST 6501 | Design & Analysis of Experiments | T | MC | 6 | 6 |

| VI | UST 6502 | Operations Research | T | MC | 6 | 6 |
|----|----------|---------------------|---|----|---|---|
| VI | UST 6503 | Statistical Quality Control | T | MC | 6 | 6 |
| VI | UST 6705 | Internship | P | MS | 3 | 100[#] |
| | UST 6706 | Python for Statistics | L | MS | 6 | 6 |
| | UST 6708 | Project | P | MS | 6 | 6 |

[&] Outside College Working Hours          [#] Full one Month off-campus

## OFFERED TO OTHER DEPARTMENTS

| Sem. | Sub. Code | Course Title | T/L/P | Category* | Credit | Hours |
|------|-----------|--------------|-------|-----------|--------|-------|
| II | UST 2301 | Business Statistics [for Commerce General] | T | AR | 3 | 6 |
| II | UST 2302 | Mathematical Statistics [for Mathematics] | T | AR | 3 | 6 |
| III | UST 3401 | Python Programming [for Mathematics & Physics] | L | AO | 3 | 5 |
| III | UST 3801 | Basic Statistics [for ALL other departments] | T | NME | 2 | 3 |
| IV | UST 4401 | Probability & Distributions [for Physics] | T | AO | 3 | 5 |
| IV | UST 4801 | Data analysis using SPSS [for ALL other departments] | L | NME | 2 | 3 |

## NON MAJOR ELECTIVE (NME) OPTIONAL SUBJECTS TO STATISTICS STUDENTS:

| Sem. | Sub. Code | Course Title | T/L/P | Category | Credit | Hours |
|------|-----------|--------------|-------|----------|--------|-------|
| III | UAZ 3801 | Conservation Biology | T | NME | 2 | 3 |
| | UBC 3801 | Entrepreneurship | | | | |
| | UBU 3801 | Business Leadership | | | | |
| | UCA 3801 | Animation | | | | |
| | UCH 3801 | Chemistry in everyday Life | | | | |
| | UCS 3801 | Introduction to Data Analytics | | | | |
| | UEC 3801 | Green Economics | | | | |
| | UEL 3801 | Popular Writing for Media | | | | |
| | UFR 3801 | Spoken French – II | | | | |
| | UFR 3802 | Elementary French – I | | | | |
| | UHT 3801 | History of Architecture in India | | | | |

| | Code | Title | | | | |
|---|---|---|---|---|---|---|
| | UMM 3801 | Visualization for Animation | | | | |
| | UMT 3801 | Mathematics for Competitive examinations | | | | |
| | UOL 3801 | Hindi for Beginners – I | | | | |
| | UOL 3802 | Hindi for Communications – I | | | | |
| | UOL 3803 | Sanskrit Through Stories – I | | | | |
| | UPB 3801 | Herbal Medicines | | | | |
| | UPH 3801 | Workshop Practice and Wiring | | | | |
| | USO 3801 | Gender and Society | | | | |
| | USO 3802 | Sociology of Crime and Deviance | | | | |
| | UTL 3801 | Basic Tamil – I | | | | |
| | UTL 3802 | Advance Tamil – II | | | | |
| | UVC 3801 | Basic Photography | | | | |
| IV | UAZ 4801 | Green technology | | | | |
| | UBC 4801 | Fundamentals of Investment | | | | |
| | UBU 4801 | Business Models | | | | |
| | UCA 4801 | Web Design | | | | |
| | UCH 4801 | Basic Clinical and Pharmaceutical Chemistry | | | | |
| | UEC 4801 | Entrepreneurial Economics | | | | |
| | UEL 4801 | Award Winning Fiction | | | | |
| | UEL 4802 | Popular Writing for Media | | | | |
| | UFR 4801 | Spoken French | | | | |
| | UFR 4802 | Elementary French | | | | |
| | UOL 4803 | Sanskrit Through Stories – II | T | NME | 2 | 3 |
| | UHT 4801 | Cultural Diversity of India | | | | |
| | UMM 4801 | Media Studies | | | | |
| | UMT 4801 | Popular Astronomy | | | | |
| | UOL 4801 | Hindi for Beginners – II | | | | |
| | UOL 4802 | Hindi for Communication – II | | | | |
| | UPB 4801 | Mushroom Cultivation | | | | |
| | UPH 4801 | Electronic Gadgets | | | | |
| | USO 4801 | Families and Intimate Relationship | | | | |
| | USO 4802 | People Power and Politics | | | | |
| | UTL 4801 | Basic Tamil – II | | | | |
| | UTL 4802 | Advanced Tamil – II | | | | |
| | UVC 4801 | Design Basics | | | | |

**Semester I**

**COURSE DESCRIPTOR**

| | |
|---|---|
| **Course Code** | **UST 1501** |
| **Course Title** | **STATISTICAL METHODS** |
| **Credits** | **06** |
| **Hours/Week** | **06** |
| **Category** | **MAJOR CORE (MC)** |
| **Semester** | **I** |
| **Regulation** | **2019** |

**Course overview:**

1. Statistical Methods imparts fundamental ideas about Statistics and research.
2. Descriptive Statistics helps to visualize the next level of analysis.
3. Statistical Methods also provides tools to systematically analyse data and draw conclusions for all real-life issues.
4. This course provides vital tools that are necessary to learn related subjects such as Economics, Commerce, Actuarial, Finance, etc.,
5. This course paves way to gain knowledge and do research in various fields of human activities like business, banking, administration, planning, etc.,

**Course Objective:**

1. To incorporate basic data handling procedures.
2. To develop appropriate data reduction techniques.
3. To understand the relationship between the variables/attributes in a given dataset.
4. To apply statistical tools for drawing meaningful inferences.

| | |
|---|---|
| **Prerequisites:** | Basic Mathematical Knowledge |

| UNIT | CONTENT | HRS | COs | COGNITIVE LEVEL |
|------|---------|-----|-----|-----------------|
| | **SYLLABUS** | | | |
| I | Definition - Scope and limitations of Statistics - Collection of data - Census. Sampling surveys - Classification and tabulation - diagrammatic and graphical representation of data - Nominal, ordinal and interval scaling. | 14 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| II | Measures of central tendency - Measures of dispersion and Coefficient of variation - Problems based on raw data and grouped data - Moments - raw and central - Measures of skewness - Measures of Kurtosis and their applications. | 20 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| III | Curve fitting - Principle of least squares - linear, nonlinear, exponential and growth curves. | 14 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| IV | Correlation - Rank Correlation - Regression analysis - Problems based on raw data and grouped data. | 15 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| V | Association of attributes - Notations - Classes and class frequencies - Consistency of data - Independence of attributes - Yule's coefficient of association - coefficient of colligation. | 15 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |

**Text Books:**

1. Bansilal and Arora (1989). New Mathematical Statistics, Satya Prakashan, New Delhi.
2. Gupta. S.C. & Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi.
3. Goon A.M. Gupta. A.K. & Das Gupta, B. (1987) . Fundamentals of Statistics, Vol.2, World Press Pvt. Ltd., Calcutta.
4. Kapoor, J.N. & Saxena, H.C. (1976) . Mathematical Statistics , Sultan Chand and Sons Pvt. Ltd, New Delhi.
5. Gupta S.P. (2014). Statistical Methods, Sultan Chand & Sons Pvt. Ltd. New Delhi.

**Suggested Readings:**

1. Levin Richard, L., David Rubin, S., et.al. (2017). Statistics for Management, 8th Edition, Pearson Education.

2. Gupta M.P. and Gupta S.P. (2019). Business Statistics, Sultan Chand and Sons Pvt. Ltd,New Delhi.

3. Gupta S.C.  and Kapoor V.K. (2009) Fundamentals of Applied Statistics, Sultan Chand and Sons Pvt. Ltd, New Delhi.

4. Philip Bobko (2002). Correlation and Regression: Applications for Industrial Organizational Psychology and Management, Sage Publications Inc.

5. Arumugam S. and Thangapandi Isaac A. (2007). Statistics, New Gamma publishing House.

6. Agarwal B.L (2013). Basic Statistics, New Age International Publishers, 6TH Edition

**Web Resources:**

1. http://eagri.org/
2. http://egyankosh.ac.in/
3. http://nsdl.niscair.res.in/

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 1501 STATISTICAL METHODS (MC) | | Cognitive Levels |
|---|---|---|
| **CO 1** | Understand and present data meaningfully | K1, K2 |
| **CO 2** | Apply summary measures of averages and dispersion to draw useful conclusions | K3 |
| **CO 3** | Statistically analyze the strengths of relationship between variables. | K4 |
| **CO 4** | Evaluate real-life problems and draw inferences | K5 |
| **CO 5** | Construct suitable statistical models to handle various socio-economic phenomena | K6 |

# COURSE DESCRIPTOR

| Course Code | UST 1502 |
|---|---|
| Course Title | **Probability and Discrete Distributions** |
| Credits | **06** |
| Hours/Week | **06** |
| Category | **Major Core (MC) - Theory** |
| Semester | **I** |
| Regulation | **2019** |

**Course Overview:**

1. Probability theory is a branch of mathematics concerned with the analysis of random phenomena.
2. Probability is a measure of the likelihood of an event to occur. Many events cannot be predicted with total certainty. We can predict only the chance of an event to occur i.e. how likely they are to happen, using probability.
3. This course helps the students to familiarize students with the ways in which we talk about uncertainty and look at everyday situations in which probability arises.
4. Many physical systems can be modeled by the same or similar random experiments and random variables. The distribution of the random variables involved in each of these common systems can be analyzed, and the result of that analysis can be used in different applications.
5. In this course, students understand the analysis of random experiments and discrete random variables.

**Course Objectives:**

1. To understand the basic principles of probability including the laws for unions, intersections, and complementation, Bayes theorem and use these principles in problem solving situations.
2. To understand the definitions of discrete, continuous, and joint random variables, compute the mean, variance and covariance of random variables, know the definition of mass (density) function and distribution function of a random variable and be able to find one from the other, and be able to find the marginal mass (density) function and distribution functions from the joint mass (density) function and distribution function.
3. To provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications of real time data.

| Prerequisites: | Basic Knowledge of Mathematics, Calculus, Permutations and Combinations |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **CO's** | **COGNITIVE LEVEL** |
| I | Random Experiment – Sample space – Events – Algebra of events- Equally likely, mutually exclusive and exhaustive events – Frequency – Classical – Axiomatic approach –Theorems in probability- problems. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | Conditional Probability – Multiplication Theorem – Independence of events problems – Compound Probability, Bayes Theorem – Applications. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | Random variables – Probability mass function – Probability density function – Distribution function, properties – Joint Distribution of two random variables marginal and conditional distributions-Independence. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | Expectation of random variables – properties – Theorems on Expectation of Sum and product of two random variables.  MGF, mean, variance, moments, covariance, correlation coefficient. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | Bernoulli trials – Binomial – Poisson – Hypergeometric – Negative Binomial – Geometric Distributions – properties. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books:**

1. Rohatgi (1993) – An Introduction to Probability theory and mathematical statistics – willey Easten, New Delhi.

2. Gupta SC and Kapoor VK (1980) – Fundamentals of Statistics. Sultan chand and Sons. New Delhi.

3. Parzen, E. (1960). Modern Probability Theory. John Willey & Sons, New York.

**Suggested Readings:**

1. Hogg, R.V. and Craig, A.T. (2002). Introduction to Mathematical Statiatics. Peaarson Education India.

**Web Resources:**

1. http://www.ru.ac.bd/stat/wp-content/uploads/sites/25/2019/03/501_06_Rohatgi_An-Introduction-to-Probability-and-Statistics-Wiley-2015.pdf

2. https://www.usb.ac.ir/FileStaff/7344_2018-12-2-10-44-10.pdf

3. http://www.ru.ac.bd/stat/wpcontent/uploads/sites/25/2019/03/302_02_Hogg_Introduction-to-Mathematical-Statistics-6th-ed.pdf

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 1502 Probability & Discrete Distributions | | Cognitive Level |
|---|---|---|
| CO 1 | To understand and recall the basic concepts in permutations and combinations and principles of probability theory. | K1,K2 |
| CO 2 | To apply the basic probability rules, including additive and multiplicative laws, independent and mutually exclusive events in probability models. | K3 |
| CO 3 | To derive the marginal and conditional distributions of bivariate random variables. | K4 |
| CO 4 | To explain the mathematical expectation and moments and solve the problems related to discrete andom variables. | K5 |
| CO 5 | To identify the type of statistical situation to which different distributions can be applied. | K6 |

**COURSE DESCRIPTOR**

| Course Code | UST 2501 |
|---|---|
| Course Title | **CONTINUOUS DISTRIBUTIONS** |
| Credits | **06** |
| Hours/Week | **06** |
| Category | **Major Core(MC) - Theory** |
| Semester | **II** |
| Regulation | **2019** |

**Course Overview:**

1. The subject of 'Continuous Distributions' is a major core area in Statistics.

2. The course aims at providing basic knowledge about theoretical distribution models that can suit different phenomena of interest measured as variables in a continuum.

3. The methods taught in the course will enable students to fine-tune their mathematical skills acquired in their Allied Mathematics course of first semester and tune it to the needs of delving deeper into Statistics

4. The contents of this course will explore the summary characteristics of various continuous distributions towards fitting them into real-time situations.

5. The course will bring out the all-pervasive nature of the normal distribution in a wide spectrum of applications.

**Course Objective:**

1. To understand the nature of variables measured in a continuum and ways of handling the same.

2. To acquire knowledge of quantifying uncertainty associated with continuous variables in terms of continuous distributions.

3. To learn the methods of obtaining summarizing measures of continuous distributions.

4. To model a given situation with a continuous probability law towards drawing conclusions in an environment of uncertainty.

| Prerequisites | Calculus, Algebra, Probability |
|---|---|

| UNIT | CONTENT | HOURS | CO's | COGNITIVE LEVEL |
|------|---------|-------|------|-----------------|
| | **SYLLABUS** | | | |
| I | Joint, Marginal and Conditional distributions – Condition mean and variance – Stochastic Independence; Uniform distribution and properties – Simulation from uniform (0,1) distribution and other general continuous distributions | 16 | CO 1 CO 2 CO 3 CO4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | Normal distribution –Properties – MGF – Linear Combinations of normal variates –Normal approximation to discrete distributions – Numerical computations using the approximation | 17 | CO 1 CO 2 CO 3 CO4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | Other Continuous Distributions – Beta, Gamma, Cauchy, Exponential – Properties; Normal approximations to specific continuous distributions – Numerical computations using the approximations | 15 | CO 1 CO 2 CO 3 CO4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | Transformations of random variables –Density functions of transformed variables by finding Jacobian; Chi-square, t and F distributions; Distributions of the sample mean and sample variance for samples from a normal population | 15 | CO 1 CO 2 CO 3 CO4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | Order Statistics – Distribution function and Density function of $1^{st}$ and $n^{th}$ order statistics; Definition of Limiting distributions of Sample Statistics; Lindeberg-Levy Central limit Theorem | 15 | CO 1 CO 2 CO 3 CO4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books**

1. Hogg, R.V. & Craig, A.T. (2002):- Introduction to Mathematical Statistics. Pearson Education India.

2. Rohatgi, V.K. and Saleh, A. K. Md. E (2002) :- An Introduction to Probability and Statistics. John Wiley & Sons, New York.

3. Goon, A.M., Gupta, M.K., & DasGupta, B. (1998):- Fundamentals of Statistics – Vol II. World Press, Kolkata.

**Suggested Readings**

1. Gupta, S.C. & Kapoor, V.K. (2000): Fundamentals of Mathematical Statistics, 10th Ed. Sultan Chand & Sons, New Delhi

**2.** Arora, S. & Bansilal (1989):- New Mathematical Statistics. Satya Prakashan, New Delhi.

**Web Resources**

1. https://www.probabilitycourse.com
2. https://mathworld.wolfram.com
3. https://www.sciencedirect.com/topics/mathemtics/order-statistics

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 2501 CONTINUOUS DISTRIBUTIONS (MC) | | Cognitive Level |
|---|---|---|
| **CO1** | To examine Joint, Marginal and Conditional Distributions, describe and identify normal and other distributions, employ calculus methods and establish properties of distributions. | **K1** **K2** |
| **CO2** | Discover and Discuss the properties of normal and other distributions, analyze the characteristics and deduce the distributions of transformed variables, | **K3** |
| **CO3** | Formulate various distributions as models for relevant situations, recognize and relate sample statistics to different distributions and compute the chances of occurrences of events concerning continuous variables | **K4** |
| **CO4** | Summarize the roles of different distributions in practical situations and illustrate with examples the nature of limiting distributions for large samples | **K5** |
| **CO5** | Justify and the use of normal distribution and adapt it as a model for relevant situations – Generalize it to bivariate case | **K6** |

# COURSE DESCRIPTOR

| Course Code | UST 2502 |
|---|---|
| Course Title | **APPLIED STATISTICS** |
| Credits | **05** |
| Hours/Week | **06** |
| Category | **MAJOR CORE (MC)** |
| Semester | **II** |
| Regulation | **2019** |

**Course Overview:**

1. This course provides the study of data related to time, psychology and life.
2. It emphasizes on index numbers and their types.
3. This course also deals with the mathematical models for time series data ,demand and Supply analysis.
4. Mortality and Fertility rates are arrived at using vital statistics.
5. Different Scaling procedures are studied for educational and Psychological data.

**Course Objective:**

1. To understand the basic problems in the construction of index numbers and to know various types of index numbers.
2. To study the numerous scaling procedures and reliability of test scores pertaining to Education and Psychology.
3. To construct the life table using Vital statistics.
4. To formulate linear and non-linear models for Time series data and give projections for future.
5. To analyse the demand and supply of various products with respect to their elasticity.

| Prerequisites: | Mathematical Knowledge |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **COs** | **COGNITIVE LEVEL** |
| I | **Index numbers:** Basic problems in construction of index numbers. Methods-Simple and Weighted aggregate-Average of price relatives-Chain base method. Criteria of goodness-Unit test , Time Reversal Factor Reversal and Circular tests. Base Shifting, Splicing and deflating index numbers. Wholesale and Consumer price index numbers. Index of industrial production. | 15 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| II | **Educational and Psychological Statistics:** Scaling procedures-Scaling of individual items, Scaling of scores, Scaling of rankings and  ratings. Reliability of test scores-Index of reliability, Parallel tests. Methods of determining test reliability. Effect of test length and ranges on reliability. | 15 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| III | **Vital Statistics:** Uses and Methods of obtaining vital statistics. Rates and Ratios. Measurement of Mortality-Crude, Specific and Standardized death rates. Stationary and Stable population, Construction of life table. Measurement of Fertility- Crude, General ,Specific and Total Fertility rates. Gross and Net Reproduction rates | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| IV | Mathematical models .Measurement of Trend : Graphic, Semi-averages, Moving  averages. Least Squares – Straight line, Second degree parabola, Exponential curve, Modified Exponential curve, Gompertz curve and Logistic curve. Measurement of Seasonal variation by Ratio-to-Moving average method. Exponential smoothing , Holt Winter's method and Box-Jenkinson's method(only algorithm). | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| V | **Demand Analysis:** Introduction-Demand and Supply, Price elasticity of demand and supply, partial and cross elasticities of demand. Types of data required for estimating elasticity. Methods of estimating demand functions: Leontief 's and Pigou's methods. Engel's law and Engel's curves. Pareto's law of law of income distribution. Utility function. | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |

**Text Books:**

1. Gupta S.C. and Kapoor V.K. (2007) :Fundamentals of Applied Statistics , 4[th] edition ,Sultan Chand &Sons Publishers, New Delhi.
2. Wayne W. Daniel and James C. Terrel (1994 ): Business Statistics for Management and Economics, 7[th] Edition , Houghton Mifflin Company.
3. Gupta S.P. (2011) :Statistical Methods , Sultan Chand &Sons Publishers, New Delhi.

**Suggested Readings:**

1. Spyros Makridakis, Steven C. Wheelwright and Rob J .Hyndman ( 2003) :Forecasting Methods and Applications , 3[rd] Edition ,John Wiley and Sons Inc. .
2. Rebecca M. Warner (2020):Applied Statistics I : Basic Bivariate Techniques , 3[rd] edition, SAGE publications , Inc.
3. Ken Black (2012) : Applied Business Statistics: Making Better Business Decisions, 7[th] edition , Wiley India Publications.
4. Irving W. Burr (1974): Applied Statistical Methods, Academic Press.
5. Durmus Ozdemir (2016):Applied Statistics for Economics and Business , 2[nd] edition, Springer International Publishing.

**Web Sources:**

1. https://libguides.reading.ac.uk>
2. https://study.sagepub.com>
3. https://www.coursera.org>

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 2502 APPLIED STATISTICS (MC) | | Cognitive Levels |
|---|---|---|
| CO 1 | To define Index Number, Time series ,Vital Statistics ,Psychological statistics, Demand and supply functions and explain their applications. | K1, K2 |
| CO 2 | To calculate Price ,Quantity Index numbers, trend and seasonal variations and different types of scores for psychological data and to compute different mortality and fertility rates and different types of elasticity for demand and supply data. | K3 |
| CO 3 | To analyse the different types of index numbers, the different scaling procedures in dealing with psychological data, the different types of mortality and fertility rates , the methods of estimating elasticities from time series and family budget data and the methods of fitting linear and non-linear models for Time series data and estimate the future values. | K4 |
| CO 4 | To select the best tool in the construction of index number, the best method of determining test reliability and to decide the best model for Time series data. | K5 |
| CO 5 | To construct life tables, polynomial models for time series data and develop models for demand and supply data. | K6 |

**Semester III**

**COURSE DESCRIPTOR**

| Course Code | UST 3501 |
|---|---|
| Course Title | **SAMPLING THEORY** |
| Credits | 06 |
| Hours/Week | 06 |
| Category | **Major Core (MC) - Theory** |
| Semester | III |
| Regulation | 2019 |

**Course Overview:**

1. Sampling Theory deals with Sample Surveys and its superiority over census survey.
2. This course communicates about the different sources of errors in a sample survey and how to control such errors.
3. It presents different methods of selecting a sample from a population and gives a comparison among the methods.
4. It explains ways to obtain good estimates of the unknown population characteristics from the samples,
5. It also gives the advantages and limitations of different sampling techniques.

**Course Objectives:**

1. To impart basic concepts in Sampling Theory.
2. To prepare students in conducting sample surveys.
3. To explore various sampling techniques and understand their merits and drawbacks.
4. To provide appropriate estimates of the required summary measures of large populations

| Prerequisites | Basic Knowledge of Mathematics, Counting principles and distributions, |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **COs** | **COGNITIV E LEVEL** |
| **I** | **Preliminaries:**<br>Sampling Vs Census – Basic concepts of sampling – Population – Parameter – Statistic – Unbiasedness – Mean square error – simple problems. | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **II** | **Simple Random Sampling:**<br>Simple random sampling with and without replacement – Estimation of population mean – Variance of estimators – Simple problems. Sampling proportions and percentages – SRS of qualitative characteristics - Variance of the sample estimates. | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **III** | **Estimation of sample size and Confidence limits:**<br>Formula for n in sampling for proportions – formula for n with continuous data - Examples –Confidence limits for population mean and total - Examples | 15 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **IV** | **Systematic sampling:**<br>Linear, Circular, Comparisons for populations with one-dimensional linear trend. | 15 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **V** | **Use of Auxiliary Information:**<br>Stratified Sampling: Estimation of total & mean – Its variance – Allocation problems – Simple problems- Ratio Estimation, Regression Estimation. | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Books**

1. Cochran, W.G. (1977) Sampling Techniques, Wiley Eastern Company Ltd. III Edition.

2. Gupta, S.C. and Kapoor, V.K. (2009) Fundamentals of Applied statistics, Sultan Chand and Sons, IV Edition.

3. Murthy, M.N. (1967) Sampling Theory and Methods, Statistical Publishing Society, I Edition.

4. Sampath, S. (2000) Sampling Theory and Methods, Narosa Publishing House, I Edition.

**Suggested Readings:**

1. Changbao Wu (2020) Sampling Theory and practice, Springer.

2. Des Raj and Chandok, P. (1998) Sampling Theory. Narosa Publishing House.

3. Donald P. Warwick (1975) The sample survey: theory and practice. McGraw-Hill.

4. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984) Sampling theory of surveys with applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.

**Web Resources**

1. https://online.stat.psu.edu/statprogram/stat506
2. https://methods.sagepub.com/reference/the-sage-encyclopedia-of-communication-research-methods/i12785.xml
3. https://faculty.nps.edu/rdfricke/docs/5123-Fielding-Ch11.pdf
4. https://en.wikipedia.org/wiki/Sampling_(statistics)
5. https://nptel.ac.in/content/storage2/courses/111104073/Module1/Lecture1.pdf
6. http://home.iitk.ac.in/~shalab/course432.htm

## Course Outcomes (COs) and Cognitive Level Mapping

| | UST 3501 SAMPLING THEORY | Cognitive Level |
|---|---|---|
| **CO1** | To understand the principles and principal steps of sampling, and different sampling techniques. | K1, K2 |
| **CO2** | To apply different sampling techniques to take samples and compute unbiased estimates and confidence limits of population parameters. | K3 |
| **CO3** | To analyse the unbiasedness and efficiencies of estimates obtained using different sampling techniques. | K4 |
| **CO4** | To evaluate the merits and limitations of different sampling techniques. | K5 |
| **CO5** | To develop a questionnaire, organize a sample survey by implementing different sampling techniques and predict population characteristics. | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 3502 |
|---|---|
| Course Title | Matrix and Linear Algebra |
| Credits | 06 |
| Hours/Week | 06 |
| Category | MC |
| Semester | III |
| Regulation | 2019 |

**Course Overview:**

1. Linear algebra is a branch of mathematical sciences that studies systems of linear equations and the properties of matrices
2. This course will cover the mathematical analysis and implementation of theory and algorithms used to solve linear algebra problems in practice.
3. This course will enable students to acquire further skills in the techniques of linear algebra, as well as understanding the principles underlying the subject.
4. This course covers the notions of vectors, matrices, linear equations, linear transformations, Eigen values and vectors, and quadratic forms.
5. The concepts and methods learnt in this course would provide methods to solve problems involving unknown quantities of interest.

**Course Objectives:**

1. To understand the basic notions and techniques of matrices and vectors.
2. To impart the matrix methods and related mathematical techniques required for pursuing core areas of statistics.
3. To learn methods for solving systems of linear equations involving unknown quantities,
4. To acquire competence in algebraic methods involving matrices, determinants, Eigen values and Eigen vectors and quadratic forms.

| Prerequisites | Basic knowledge in Mathematics |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| UNIT | CONTENT | HOURS | Cos | COGNITIVE LEVEL |
| I | **Matrix Algebra:** Matrices – Operations on matrices - Various types of matrices - Trace of a square matrix - Determinants, Cofactors, Minors - Properties of Determinants (without proof) - Evaluation of Determinants - Singular & Non-Singular matrices. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | **Linear Equations, Inversion & Rank:** Rank of a matrix – Echelon form – Properties. Inverse of a matrix – Properties - Methods of matrix inversion. Linear Equations –Types- Non-homogeneous and homogeneous - Consistency – Solution by Cramer's rule and matrix methods. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | **Vectors & Linear Transformations:** Vector space– Linear dependence/Independence– Basis & Dimension– Linear Transformations &Properties –Matrix of a Linear Transformation –Orthogonal Transformations. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | **Eigen Values & Vectors:** Characteristic equation, Eigen roots & vector – Properties - Cayley – Hamilton Theorem – Matrix inversion by CH Theorem - Calculations of power of a matrix. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | **Quadratic Forms:** Definition– Types - Reduction of QFs to canonical forms – Congruent and Lagrange reductions – Index and Signature of QFs. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books:**

1. Vasishtha, A.R., 2014, Matrices, Krishna Prakashan Media.

2. Shanthi Narayan & Mittal, P.K., 2010, A Text Book of Matrices, Sultan Chand & Sons, New Delhi.

3. Datta, K.B., 2004, Matrix and Linear Algebra, Prentice Hall of India.

**Suggested Readings:**

1. Hohn, F. E, 2012, Elementary Matrix Algebra, Statistical Methods, 3rd Edition, Dover Publications.

2. Aggarwal, R.S, 1987, A text book on Matrices, 4th Edition, Sultan Chand & Sons, New Delhi.

3. Richard Bronson, 2005, Theory and Problems of Matrix Operations, Tata McGraw Hill.

**Web Resources:**

1. https://www.math.pku.edu.cn/teachers/anjp/textbook.pdf

2. http://www.astronomia.edu.uy/progs/algebra/Larson%20%20Edwards%20y%20Falvo%20 Elementary%20Linear%20Algebra.pdf

3. http://www.math.nagoya-u.ac.jp/~richard/teaching/f2014/Lin_alg_Lang.pdf

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 3502 - Matrix and Linear Algebra | | Cognitive Level |
|---|---|---|
| **CO 1** | To understand the concepts of algebra of real matrices, determinant and Rank of matrix. | K1,K2 |
| **CO 2** | To solve linear equations and Demonstrate with matrices. | K3 |
| **CO 3** | To explain and illustrate linear transformations between vector spaces and their representation by matrices. | K4 |
| **CO 4** | To make use of Cayley-Hamilton theorem to find Eigen values and Eigen vectors. | K5 |
| **CO 5** | To analyze and identify the nature of symmetric matrices using quadratic forms. | K6 |

| Course Code | UST 4501 |
|---|---|
| Course Title | **ESTIMATION THEORY** |
| Credits | **06** |
| Hours/Week | **06** |
| Category | **Major Core(MC) - Theory** |
| Semester | **IV** |
| Regulation | **2019** |

**Course Overview:**

1. Estimation theory deals with estimating the values of parameters based on measured/empirical data that has a random component.

2. The parameters describe an underlying physical setting in such a way that their value affects the distribution of the measured data.

3. The entire purpose of estimation theory is to arrive at an estimator, and preferably an implementable one that could actually be used. The estimator takes the measured data as input and produces an estimate of the parameters.

4. It is also preferable to derive an estimator that exhibits optimality. Estimator optimality usually refers to achieving minimum average error over some class of estimators.

5. In order to arrive at a desired estimator, it is first necessary to determine a probability distribution for the measured data, and the distribution's dependence on the unknown parameters of interest.

**Course Objective:**

1. To describe many of the important estimation methods and characteristics of the estimators

2. To Understand the problem of statistical inference with specific reference to point estimation,

3. To have deeper insight for constructing optimal estimators and tests

| Prerequisites | Linear Algebra, Probability, Random Variables and Distributions. |
|---|---|

| | **SYLLABUS** | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **CO's** | **COGNITIVE LEVEL** |
| **I** | Infinite Population – Parameters; Random Samples – Statistics; Estimators – Biased Estimators and Mean-Square Error; Unbiased Estimators and Variance; Consistent Estimators – Conditions for Consistency | 14 | CO 1<br>CO 2<br>CO3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **II** | Efficiency of Estimators – Optimality considerations– Cramer-Rao Inequality – Information in sample – Information in a statistic. Sufficient Statistics – Factorization Theorem – Rao-Blackwell Theorem. | 16 | CO 1<br>CO 2<br>CO3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **III** | Best Unbiased Estimation –UMVUE – Properties. Completeness of a family of distributions – Complete Statistic – Lehmann-Scheffe Theorem – Finding UMVUE by using Lehmann-Scheffe Theorem. | 16 | CO 1<br>CO 2<br>CO3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **IV** | Methods of Estimation – Methods of Moments, Maximum Likelihood, Minimum Chi-Square, Least Squares, Bayesian Estimation.Properties of these estimators. | 16 | CO 1<br>CO 2<br>CO3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **V** | Interval Estimation – Confidence Intervals for mean and variance of a normal population; For difference of means and ratio of variances of two normal populations; Asymptotic confidence intervals for proportions. | 16 | CO 1<br>CO 2<br>CO3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Book:**

1. Dixit, S.P. , Modi, C.S., Joshi, R.V (2000), Mathematical Basis of life Assurance, IC-81, Insurance Institute of India.

2. Frank Ayers, J.R. (1983), Theory and problems of mathematics of finance, Schaum's outline series, McGraw-Hill book company, Singapore.

3. Donald, D.W.A (1975), Compound Interest and Annuities certain, Heinemann, London.

4. Zima, P. and Brown, R.L. (2005), Theory and problems of mathematics of finance, 2nd edition, Tata McGraw – Hill.

5. McCutcheon J.J. and Scott (1989), Mathematics of Finance, Heinemann, London

6. Neill, A (1977), Life Contingencies, Heinemann, London

**Suggested Readings :**

1. Effective statistical learning methods for actuaries: I. [Generalised Linear Models] GLMs and extensions. - Denuit, M., Hainaut, D. and Trufin, J. - Springer, 2019. ISBN 978-3030258207

2. Generalized linear models. 2nd ed. McCullagh, P. and Nelder, J.A. Chapman & Hall/CRC Press, 1989. ISBN

3. John E. Freund's Mathematical statistics with applications. 8th ed. Miller, I. and Miller, M.; [Freund, J. E.] Prentice Hall International, 2013. ISBN: 978-0321904409

4. Literate programming. Knuth, D.E. Stanford CA: Centre for the Study of Language and Information, 1992. ISBN 978-093073803

5. Regression modelling with actuarial and financial implications. Frees, E.W. Cambridge University Press, 2010. ISBN: 978-0521760119

6. Report writing for data science in R. Peng, R. Victoria (Canada): Lean Publishing, 2015. ISBN 978-132973364

7. Study material actuarial science cs1 core statistics entrance examination for 2021-2022, Sourav S.

**Web Resources:**

1. https://nptel.ac.in/courses/111/105/111105043/
2. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma19/

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 4501 - Estimation Theory | | Cognitive Level |
|---|---|---|
| **CO1** | Recall the theoretical models (distributions) suitable to study different phenomena; Define and Relate Infinite populations, Parameters and Estimators; Contrast biased and unbiased estimators. | K1, K2 |
| **CO2** | Spell out optimal characteristics of estimators; Summarize Information in data; Demonstrate methods of improving the estimates. | K3 |
| **CO3** | Identify conditions for deriving optimal estimates; Draw Inference in the best possible manner. Quantify information in statistic using Fisher Information | K4 |
| **CO4** | Make use of different methods to draw inference about unknown parameters to best suit for the real time data. | K5 |
| **CO5** | Assume suitable models and Discover the salient features of a population from available data. | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 4601 |
|---|---|
| Course Title | ACTUARIAL STATISTICS |
| Credits | 06 |
| Hours/Week | 06 |
| Category | Major Elective (ME) - Theory |
| Semester | IV |
| Regulation | 2019 |

**Course Overview:**

1. Actuarial Statistics helps to assess financial risks in the insurance and finance fields, using mathematical and statistical methods

2. Actuarial Statistics gives knowledge in foundational areas of mathematics as well as finance and economics essential to the actuarial field.

3. Actuarial Statistics applies probability analysis and statistics to define, analyze, and solve the financial impact of uncertain future events.

4. This course imparts actuarial techniques accurately, precisely and effectively by developing mathematical and critical thinking.

5. This course gives motivation to appear in the actuarial examinations conducted by different societies and complete it successfully,

**Course Objective:**

1. To impart basic concepts in actuarial studies
2. To prepare students to take up a career in Actuarial Practice
3. To explore some of the fiscal and ethical dilemmas often encountered in the process of business decision-making.
4. To put big data into context and prepare for a coveted career that is consistently found at the top of "best jobs" lists.

| Prerequisites | Basic Knowledge of Mathematics, Statistics, Economics and Computer |
|---|---|

| | | SYLLABUS | | | |
|---|---|---|---|---|---|
| **UNIT** | **CONTENT** | | **HOURS** | **CO's** | **COGNITIVE LEVEL** |
| **I** | **Effective and Nominal Rate**<br>Effective Rate of Interest i - Nominal Rate of Interest $i^{(m)}$ - Force of Interest δ - Relationships between different rates of interest - Expression for δ by use of calculus - Present values - Effective rate of discount d - Nominal rate of discount $d^{(m)}$. | | 14 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **II** | **Accumulation and Present values of Annuity**<br>Annuities - Immediate Annuity - Annuity-due - Perpetuity - Accumulation and Present values of Annuities - Increasing and Decreasing annuities - Annuities and interest rates with different frequencies - Continuous Annuities. | | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **III** | **Annuity payments and Loan outstanding**<br>Analysis of Annuity payments - Capital and Interest elements included in the Annuity payments - Loan outstanding after t payments - Purchase price of Annuities - Annuities involving income tax - Purchase price of an annuity net of tax. | | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **IV** | **Office and Net Premiums**<br>Premiums - general principles - natural premiums - office & net premiums - loading for expenses with and without profit premiums - adequacy of premiums -relative consistency - Simple Problems | | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **V** | **Stochastic Interest Rate**<br>Stochastic Interest rates - Independent annual interest rates - The definition of Sn - Mean and variance of Sn - Definition of An - Mean and variance of An - Simple problems. | | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Book:**

1. Dixit, S.P. , Modi, C.S., Joshi, R.V (2000), Mathematical Basis of life Assurance, IC-81, Insurance Institute of India.
2. Frank Ayers, J.R. (1983), Theory and problems of mathematics of finance, Schaum's outline series, McGraw-Hill book company, Singapore.
3. Donald, D.W.A (1975), Compound Interest and Annuities certain, Heinemann, London.
4. Zima, P. and Brown, R.L. (2005), Theory and problems of mathematics of finance, 2$^{nd}$ edition, Tata McGraw – Hill.
5. McCutcheon J.J. and Scott (1989), Mathematics of Finance, Heinemann, London
6. Neill, A (1977), Life Contingencies, Heinemann, London

**Suggested Readings :**

1. Effective statistical learning methods for actuaries: I. [Generalised Linear Models] GLMs and extensions. - Denuit, M., Hainaut, D. and Trufin, J. - Springer, 2019. ISBN 978-3030258207
2. Generalized linear models. 2nd ed. McCullagh, P. and Nelder, J.A. Chapman & Hall/CRC Press, 1989. ISBN
3. John E. Freund's Mathematical statistics with applications. 8th ed. Miller, I. and Miller, M.; [Freund, J. E.] Prentice Hall International, 2013. ISBN: 978-0321904409
4. Literate programming. Knuth, D.E. Stanford CA: Centre for the Study of Language and Information, 1992. ISBN 978-093073803
5. Regression modelling with actuarial and financial implications. Frees, E.W. Cambridge University Press, 2010. ISBN: 978-0521760119

**Web Resources:**

1. https://ocw.mit.edu/courses/mathematics/18-650-statistics-for-applications-fall-2016/lecture-videos/lecture-1-introduction-to-statistics/
2. https://nptel.ac.in/courses/112/107/112107260/#video
3. https://nptel.ac.in/courses/111/105/111105041/#watch
4. https://www.edx.org/course/introduction-to-actuarial-science
5. https://www.classcentral.com/course/edx-introduction-to-actuarial-science-3875

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 4601 ACTURIAL STATISTICS | | Cognitive Level |
|---|---|---|
| CO1 | Define and spell out the relation between various types of rates of interest, annuities, premiums and rates of discount | K1, K2 |
| CO2 | Classify different types of annuities and premiums and summarize its accumulation and present values using different types of rates of interest | K3 |
| CO3 | Analyze Annuity Payments, Annuity involving income tax, their purchase prices and finding premium for various actuarial policies | K4 |
| CO4 | Distinguish the different types of annuities and premiums then compare their adequacy and relative consistency. | K5 |
| CO5 | Apply the ideas of stochastic interest rates and independent annual interest rates to practical situations for annuities and premiums | K6 |

## Course Descriptor

| | |
|---|---|
| **Course Code** | **UST 4602** |
| **Course Title** | **Data Mining** |
| **Credits** | **06** |
| **Hours/Week** | **06** |
| **Category** | **Major Elective (ME) - Theory** |
| **Semester** | **IV** |
| **Regulation** | **2019** |

**Course Overview:**

1. The course provides the opportunity to learn techniques that have been designed to efficiently find interesting pieces of information or knowledge in large amounts of data.

2. To learn concepts, principles, and skills to practice and engage in scalable pattern discovery methods on massive data

3. To discuss pattern evaluation measures; study methods for mining diverse kinds of frequent patterns, sequential patterns, and sub-graph patterns.

4. In this course we explore how this interdisciplinary field brings together techniques from databases, statistics, machine learning, and information retrieval.

5. To discuss the main data mining methods currently used, including data warehousing and data cleaning, clustering, classification, association rules mining, and searching algorithms, and recent techniques for web mining.

**Course Objective:**

1. To introduce students to the basic concepts and techniques of Data Mining.

2. To introduce a wide range of clustering, estimation, prediction, and classification algorithms.

3. To introduce mathematical statistics foundations of the Data Mining Algorithms.

4. To prepare students to take up a career in data mining

5. To explore some of the fiscal and ethical dilemmas often encountered in the process of business decision-making.

6. To put big data into context and prepare for a coveted career that is consistently found at the top of "best jobs" lists.

| **Prerequisites:** | Basic Knowledge of Mathematics, Statistics and Computer Science |
|---|---|

| UNIT | CONTENT | HRS | CO's | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **Introduction to Data Mining &Pre processing** Introduction to Data mining, Cross-Industry Standard Process for Data Mining: CRISP-DM, Supervised and Unsupervised learning, Data Pre-processing - Data Cleaning, Handling Missing Data, Removal of Duplicate Records. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | **Data Transformations** Min–Max Normalization, Z-Score Standardization, Transformations to Achieve Normality, Numerical Methods for Identifying Outliers, Transforming Categorical Variables into Numerical Variables, Univariate - Tabulation and Visualizations, Equal Height Binning, Equal width binning. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | **Exploratory Data Analysis & Decision trees** Bivariate - Tabulation and Visualizations - Scatter plot, Box Plot, Bubble chart, Radar chart, Dual axis chart, Graphical Methods for Identifying Outliers. Classification Problem, Gini Coefficient, Entropy, Classification Tree Algorithm, Regression tree algorithm. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | **Kth Nearest Neighborhood and Naive** **Bayes Classification** Distance measures, Association measures, Kth nearest neighborhood method of classification and Regression, Prior probability, Bayes Theorem, Naive Bayes classification. | 16 | CO1 CO2 CO3 C04 CO5 | K1 K2 K3 K4 K5 K6 |
| V | **Introduction to ANN and Association Rule Mining** Inspiration of Artificial Neural Network from Brain Functioning, Data transformations, Network structure, Weight function, Activation function, Back propagation algorithm, Transaction data, Frequent itemset, Apriori algorithm. | 16 | CO1 CO2 C03 C04 C05 | K1 K2 K3 K4 K5 K6 |

**Text Book:**

1. Jiawei Han, Jian Pei, Micheline Kamber (2012),Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers.

2. VikramPudi, P. Radha Krishna (2009), Data Mining, Oxford University.

3. Stephane Tuffery (2011), Data Mining and Statistics for Decision Making, Wiley Publication.

4. Pang-Ning Tan Michael Steinbach Anuj Karpatne Vipin Kumar (2021), Introduction to Data Mining, Pearson Publication.

5. Charu.C.Aggarwal (2012), Data Mining, Springer Publication.

6. Daniel T. Larose (2015), Data Mining and Predictive Analytics (Wiley Series on Methods and Applications in Data Mining)

**Suggested Reading:**

1. Parteek Bhatia (2019), Data Mining and Data Warehousing: Principles and Practical Techniques, Cambridge.

**Web Resources:**

1. https://www.kdnuggets.com/
2. http://statpages.org/
3. http://www.statistics.com/
4. http://www.crisp-dm.org/

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 4602 - Data Mining | | Cognitive Level |
|---|---|---|
| CO 1 | Identify the key processes of data mining and knowledge discovery process. Understand the basic principles and algorithms used in practical data mining and their strengths and weaknesses. | K1, K2 |
| CO 2 | Apply data transformation and summarization techniques. | K3 |
| CO 3 | Analyze, discover and measure interesting patterns from different kinds of databases | K4 |
| CO 4 | Evaluate and select appropriate data mining algorithms and apply, interpret and report the output | K5 |
| CO 5 | Design and implement data mining application using real time data sets and modern tools | K6 |

**Semester V**

**COURSE DESCRIPTOR**

| Course Code | UST 5501 |
|---|---|
| Course Title | APPLIED STOCHASTIC PROCESSES |
| Credits | 06 |
| Hours/Week | 06 |
| Category | MAJOR CORE (MC) |
| Semester | V |
| Regulation | 2019 |

**Course Overview**

1. Applied Stochastic Processes deals with mathematical models of systems and phenomena that appear to vary in a random manner.
2. This course provides the classification and types of stochastic processes.
3. The aim of the course is to emphasize on Markov process and its applications.
4. It includes the study of Discrete time Markov chains involving Transition probability matrix,
5. Limiting probabilities and Stationary distributions are found.
6. Continuous time Markov chains encompassing Poisson process, Birth process ,Birth and Death process, Renewal process , Branching process and their properties are studied.

**Course Objective**

1. To understand the concept of Stochastic process and its types.
2. To comprehend the transition probabilities of one-step and n-step and Chapman-Kolmogorov equation.
3. To know how to calculate limiting probabilities and find stationary distribution.
4. To derive the distribution of Poisson process, Birth process, Birth-Death process Renewal and Branching processes.

| Prerequisites | Mathematical Knowledge |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| UNIT | CONTENT | HOURS | COs | COGNITIVE LEVEL |
| I | Introduction to Stochastic Processes: Definition-Examples, Classification-Different types of Stochastic processes. | 14 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| II | Discrete -time Markov chains: Definition , properties and examples, Transition probability matrix, Chapman-Kolmogorov equations, Calculation of n-step transition probabilities, limiting probabilities, stationary distribution-Applications. | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| III | Continuous-time Markov chains: Poisson process-properties, Pure birth process-Yule's process-Birth and Death process-Applications. | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| IV | Renewal process: Definition-Examples, properties, Renewal equation , Renewal theorem, Applications. | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |
| V | Branching process- Examples, generating function-mean and variance, Extinction probabilities-Illustration. | 16 | CO1 CO2 CO3 CO4 CO5 | K1 K2 K3 K4 K5 K6 |

**Text Books:**

1. Karlin S and Taylor M 1975 :A First Course in Stochastic processes ,Academic Press, New York.

2. Medhi J 1994 :Stochastic Processes , Wiley Eastern Ltd. New Delhi.

**Suggested Readings:**

1. Howard M Taylor and Samuel Karlin 1998 : Introduction to Stochastic modelling, Academic Press, New York.

2. Ross S. M. 1983 : Stochastic Processes, John Wiley and Sons, New York.

3. Richard Durrett 2016 : Essentials of Stochastic Processes, Third Edition , Springer International Publishing, Switzerland.

4. Paul,G.Hoel, Sidney C. Port and Charles J. Stone 1987:Introduction to Stochastic Processes, Waveland Press Inc., U.S.A.

**Web Sources:**

1. https://searchworks.stanford.edu
2. https://www.journals.elsevier.com
3. https://www.routledge.com
4. https://www.researchgate.net

## Course Outcomes (COs) and Cognitive Level Mapping

| UST   APPLIED STOCHASTIC PROCESSES  (MC) | | Cognitive Levels |
|---|---|---|
| CO 1 | To define the different types of stochastic processes and give examples for them. | K1, K2 |
| CO 2 | To classify the Stochastic process and compute one-step and n-step transition probabilities, excess and current life for renewal process and extinction probabilities for branching process. | K3 |
| CO 3 | To apply Chapman-Kolmogorov equation for deriving various processes and examine the recurrence for the  states of Markov chain. | K4 |
| CO 4 | To compare Poisson process, birth and death process, renewal process and branching process and analyse their properties. | K5 |
| CO 5 | To analyse various processes with respect to their applications. | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 5502 |
|---|---|
| Course Title | **BIOSTATISTICS AND SURVIVAL ANALYSIS** |
| Credits | **06** |
| Hours / Week | **06** |
| Category | **Major Core (MC) - Theory** |
| Semester | **V** |
| Regulation | **2021** |

**Course Overview :**

1. Biostatistics is a collection of methods and techniques in Statistics applied in the field of Health Sciences

2. Biostatistics focus on estimating risk associated to drug interventions or treatment procedures or exposure.

3. Techniques in Survival Analysis are designed to compare survival curves of individuals or group and also in determining the factors influencing survival time

4. This Course covers the different phases of clinical trials which are vital in understanding the different phases in new drug development

5. This course focus on encouraging the Students to take up career as Biostatistician in various pharmaceutical companies and research organizations

**Course Objective:**

1. To impart the applications of Statistical Measures in health sciences.

2. To explore various Data Visualizations and Statistical Inference in Biostatistics and Survival Analysis

3. To explore the applications of Statistical Models in Survival Analysis

4. To encourage Students to take up a career as Biostatistician

| **Prerequisites:** | Basic Knowledge in Probability, Discrete and Continuous Distributions, Estimation Theory and Testing of Statistical Hypothesis |
|---|---|

| | **SYLLABUS** | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **CO's** | **COGNITIVE LEVEL** |
| I | **Study Designs and Statistical Measures** Introduction To Study Designs- Different Types Of Observational Studies –Experimental Studies. Epidemiology – Odds- Odds Ratio- Confidence Interval for Odds Ratio- Control Event Rate – Experimental Event Rate – Relative Risk. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | **Statistical Inference in Clinical Studies** Point Estimation and Confidence Intervals, Parametric and Non-parametric tests - Research questions about one sample and two sample problems for means, proportions. Independence of attributes by contingency tables. Sample size determination in testing procedures involving one population and two populations. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | **Contributions in Drug Discovery** General Information On Drug Discovery Including Louis Pasteur (Rabies, Small Pox) Ronald Ross (Malaria), Alexander Fleming (Penicillin) Jonas Salk (Polio) , Cholera, Asthma , Diabetes, Blood Pressure, Heart Attack, Arthritis. Phases of Clinical Trials – Purpose – Duration Cost , Etc- Drug Regulatory Bodies – ICH , Etc. | 12 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | **Fitting of Parametric Survival Distributions** Derivation of S(t) and h(t) for Weibull, Exponential, Gamma and Lognormal distributions, ML Estimation of parameters with numerical examples, Goodness of fit tests. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | **Nonparametric methods in survival analysis** Type I, Type II and Type III censoring, Estimation of Survival Function S(t) using Kaplan-Meier method, Comparison of Survival curves between two groups using Log Rank Test, Cox-proportional Hazard model. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books**

1. Basic & Clinical Biostatistics, Dawson, Beth & Robert, G, Mcgraw-Hill Publication, 2001, Edition IV
2. Statistical Methods For Survival Data Analysis, Ellisa T.Lee, Lifetime Learning Publications, 1992, Edition III

**Suggested Readings**

1. Survival Analysis, David G. Kleinbawn, Springer Publication, 1996, Edition II
2. Introducing To Randomized Controlled Clinical Trials, Chapman And Hall, Mathews, J.N.S, CRC Press, 2006, Edition II

**Web Resources**

1. https://www.britannica.com/technology/pharmaceutical-industry/Drug-discovery-and-development
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1200696
3. https://www.cancer.org/treatment/treatments-and-side-effects/clinical-trials/what-you-need-to-know/phases-of-clinical-trials.html
4. https://www.fda.gov/patients/learn-about-drug-and-device-approvals/drug-development-process

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 5502 – Biostatistics and Survival Analysis | | Cognitive Level |
|---|---|---|
| CO1 | To Describe the contributions made by world famous scientists in the field of drug discovery and learn the steps involved in clinical trials. | K1 |
| CO2 | To Classify the study designs in medical research into the right type of observational or experimental study. | K2 |
| CO3 | To Determine and Apply correct statistical inference procedures with adequate sample size to infer problems related to Biostatistics | K3 |
| CO4 | To Recommend the best distribution fit for the given survival data and also to compare survival curves using visualization and statistical test of significance. | K5 |
| CO5 | To Develop Cox PH model for Survival Data and to estimate Adjusted survival functions for individuals and group | K4,K6 |

# Course Descriptor

| Course Code | UST 5503 |
|---|---|
| Course Title | REGRESSION ANALYSIS |
| Credits | 06 |
| Hours/Week | 06 |
| Category | Major Core(MC) - Theory |
| Semester | V |
| Regulation | 2019 |

**Course Overview:**

1. Regression Analysis is the most widely used statistical technique.

2. Regression analysis estimates relationships between independent variables and dependent variables.

3. Regression models can be used to help understand and explain relationships among variables; they can also be used to predict outcomes.

4. Regression analysis is a way of mathematically sorting out which of those variables do indeed have an impact.

5. This course help the students to understand the fundamental theory behind linear regression and, through data examples, learn to fit, examine, and utilize regression models to examine relationships between multiple variables.

**Course Objective:**

1. To develop a deeper understanding of linear regression models and its limitations;

2. To know how to diagnose and apply corrections to some problems with the generalized linear model found in real data

3. To Use and understand generalizations of the linear model to binary responses.

| Prerequisites | Basic Knowledge of Mathematics (Matrix Algebra), Distribution Theory, Estimation and Testing of Hypotheses |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **Hours** | **Co's** | **Cognitive Level** |
| **I** | Introduction to simple Regression – Mathematical and Statistical Equation – Meaning of Intercept and Slope – Error term – Measure for Model Fit – $R^2$ – MAE – MAPE – Testing Significance of Model Coefficients, Confidence interval for model coefficients. | 14 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **II** | Model diagnostics - Mean predicted value, Testing normality of error term, QQ-plot, PP-plot, Anderson Darling test, Kolmogrov Smirnov test. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **III** | Introduction to Multiple Linear Regression Model, Partial Regression Coefficients, Testing Significance and Overall fit of the model, Testing for Individual Regression Coefficients, Estimating $R^2$ , MAE and MAPE | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **IV** | Collinearity issues and Diagnostics,  Dummy Variable, Study of Interaction Effects, Varying Intercept and Slope using dummy variable, Detection and Removal of Outliers . | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **V** | Binary Logistic Regression – Introduction – Fitting of Logistic regression model – Testing for the significance of the co efficients – Measures of goodness of fit – Pearson Chi-square statistic and Deviance , Classification Table, Area under the ROC curve | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

Books for Study:

1. Montgomery,D.C. ,Peck E.A, & Vining G.G. (2003), Introduction to Linear Regression Analysis, John Wiley and Sons,Inc.NY.

2. Draper, N. R. & Smith, H (1998), Applied Regression Analysis, John Wiley, 3rd edition.

**Books for Reference:**

1. Gujarati, D.(2004), Introduction to Econometrics, McGraw Hill, New Delhi

**Web Resources:**

1. https://www/kaggle.com/
2. https://nptel.ac.in/courses/111/104/111104074
3. https://guides.emich,edu/

**Course Outcome – Cognitive level mapping**

| UST 5503 - REGRESSION ANALYSIS | | Cognitive Level |
|---|---|---|
| **CO1** | To outline the vital area of regression models applicable in a wide variety of real time situations | K1, K2 |
| **CO2** | To draw out the unknown values of predictive variables with given inputs of independent variables and use them for finding the forecasted values for future. | K3 |
| **CO3** | To formulate predictive models for the real time data and check validity of the model and if needed, modify the model to suit application problems | K4 |
| **CO4** | To assess the underlying assumptions of the model, learn how to test whether the data satisfy those assumptions and what can be done when those assumptions are not met, and develop strategies for building best models. | K5 |
| **CO5** | To classify objects/individual with respect to a binary response variable and validate the model performance | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 5504 |
|---|---|
| Course Title | TESTING OF HYPOTHESES |
| Credits | 06 |
| Hours/Week | 06 |
| Category | MAJOR CORE (MC) |
| Semester | V |
| Regulation | 2019 |

**Course Overview:**

1. This course imparts basic ideas about hypotheses testing procedures.
2. Testing of Hypotheses focuses on solving practical statistical problems.
3. This course is framed to assist the researchers of various fields.
4. Testing of Hypothesis contains essential theories to provide guidance in quality management.
5. The course covers topics which is mandatory to crack competitive exams related to Statistics.

**Course Objectives:**

1. To introduce the concepts of hypothesis testing.
2. To differentiate between large and small samples and apply apt testing procedures.
3. To explain various non-parametric tests and its applications.
4. To illustrate the concepts with various numerical examples.

| Prerequisites | Estimation Theory concepts |
|---|---|

| UNIT | CONTENT | Hours | COs | Cognitive Level |
|---|---|---|---|---|
| **SYLLABUS** | | | | |
| I | Statistical hypotheses – Null and Alternative – Simple and Composite – size and level, power of a test – Critical Region, Best Critical Region - Neyman-Pearson Lemma – Examples – p and critical value. | 15 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| II | One parameter exponential family - Families with monotone likelihood ratio property – UMP Critical Region for one-sided hypotheses (without proof) - examples. | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| III | Likelihood Ratio Tests – Properties – Tests for means and variances of normal populations – One-sample, Two-sample tests – Examples - Basic concepts of SPRT. | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| IV | Tests of significance –Tests based on normal, t, chi-square, F distributions - Goodness of fit tests – problems. | 17 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| V | Non-parametric tests - Run test for randomness - sign test for location - Median test - Mann- Whitney - Wilcoxon test – Kolmogorov- Smirnov test for distribution fitting - problems. | 17 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**TEXT BOOKS**

1. Gupta S.C and Kapoor V.K. (2002). Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

2. Hogg R.V and Craig A.T. (2002). Introduction to Mathematical Statistics, Pearson Education ( P.Ltd, Singapore).

3. Chapman and Hall. (1980). Intermediate Mathematical Statistics, New York.

4. Rohatgi V.K.and Saleh A.K.Md.E. (2002). An Introduction to Probability and Statistics John Wiley and Sons, New York.

5. Gibbons J. D. (1971). Non-parametric Statistical Inference, McGraw-Hill Kogakusha Ltd., New Delhi.

6. Mood A. M, Graybill F. A and Boes D. C. (1983) Introduction to the Theory of Statistics, McGraw-Hill, New Delhi.

**SUGGESTED READINGS**

1. Sanjay Arora and Bansi Lal (1989). New mathematical Statistics, Satya Prakashan, New Delhi.

2. Goon A.M., Gupta M.K. and Dasgupta B. (2002). Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

3. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

4. Hogg, Tanis, Rao. (2009). Probability and Statistical Inference.7th Edition. Pearson.

5. Hogg , Tanis,Rao(2009): Probability and Statistical Inference.7 th Edition. Pearson.

6. Milton J. S. and Arnold J. C. (2017). Introduction to Probability and statistics, 4th Edition, Tata McGraw hill Publication.

7. Gibbons J.D and Subhabrata Chakraborti.(2020). Non parametric Statistical Inference, 6th Edition, Chapman and Hall/CRC.

**WEB SOURCES**

1. https://online.stat.psu.edu/statprogram
2. https://www.cliffsnotes.com/study-guides/statistics
3. https://www.statisticshowto.com/
4. https://www.khanacademy.org
5. https://www.nedarc.org
6. http://egyankosh.ac.in/

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 5504 - TESTING OF HYPOTHESES (MC) | | Cognitive Levels |
|---|---|---|
| **CO 1** | Recall the basic terminologies and concepts of statistical inference | K1, K2 |
| **CO 2** | Explain the concepts and appropriate conditions needed for framing a test | K3 |
| **CO 3** | Solve the problems related to Testing of Hypotheses | K4 |
| **CO 4** | Explore and model practical situations | K5 |
| **CO 5** | Demonstrate the solution to an actual problem and evaluate whether the conclusions are reasonable. | K6 |

# COURSE DESCRIPTOR

| Course Code | UST 5601 |
|---|---|
| Course Title | DATA ANALYSIS USING MS EXCEL & SPSS |
| Credits | 06 |
| Hours/Week | 06 |
| Category | ME (Lab) |
| Semester | V |
| Regulation | 2019 |

**Course Overview**

1. This course gives a working knowledge of Excel Spread sheet and SPSS software to students with the aim of getting to use data analysis.
2. Students understand the Spreadsheet Functions to Organize Data
3. Students explore the various data filtering capabilities, graphing and charting techniques in Excel.
4. Students learn how to import and split the data into SPSS and also construct the charts and graphs.
5. Students will be able to apply appropriate statistical tool for given data set using MS Excel and SPSS Software and get the output and report the finding.

**Course Objectives**

1. To impart Data Processing skill in MS Excel
2. To develop the Data Analysis and Data Visualization skill
3. To train students in SPSS Software
4. To expose the students to the analysis of statistical data

| Prerequisites | |
|---|---|
| | Basic knowledge in estimation theory and testing of hypotheses |

| UNIT | CONTENT | Hours | Cos | COGNITIVE LEVEL |
|---|---|---|---|---|
| | **SYLLABUS** | | | |
| I | Introduction to MS Excel - MS Excel Options Using Excel Shortcuts - Link the Data in Rows, Columns and Sheet - Functions: - Logical Functions -Math and Statistical Functions – Charts-Plotting Density Function and Distribution Function. | 14 | CO 1 CO 2 CO3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | Vlookup, Hlookup, - Conditional Formatting - Data Sorting and Filtering - Pivot Tables Statistical measures - Pearson correlation – Spearman's Rank correlation – Parametric tests – test for single population mean , equality of mean for two independent sample , paired t test, testing correlation coefficient, Non parametric tests – Mann Whitney U test, Wilcoxon signed rank test – Kruskall Wallis test – One way ANOVA – Simple and Multiple Linear regression. | 16 | CO 1 CO 2 CO3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | Overview of SPSS. Open and save SPSS data file - Import from other data source - Data entry - Labeling for dummy numbers and recode in to same variable - Recode in to different variable and transpose of data - Insert variables and cases merge variables and cases - Split data - Select cases - Compute total scores. | 16 | CO 1 CO 2 CO3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | Simple Bar diagram and Multiple bar diagram - Sub-divided Bar diagram - Pie Diagram – Histogram - Scatter diagram & Box plot – Measure of central tendency and Dispersion - Karl Pearson's and Spearman's Rank Correlation – Simple and Multiple Regression. | 16 | CO 1 CO 2 CO3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | One sample &Two sample Independent t test - Paired t test - One way and Two way ANOVA. One sample KS test Mann-Whitney U test - Wilcoxon Signed Rank test & Kruskal Wallis test - Friedman test and Chi- square test. | 16 | CO 1 CO 2 CO3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books**

1. Bernd Held., 2016, Microsoft Excel Functions & Formulas, Third Edition, Mercury Learning & Information.
2. Andy Field, 2017, Discovering Statistics Using IBM SPSS Statistics, Fifth Edition, SAGE Publications Ltd

**Suggested Readings**

1. John Walkenbach, 2016, MS Excel 2016 Bible, First Edition, Wiley & Sons.
2. Jesus Salcedo , Keith McCormick , Jon Peck and Andrew Wheeler, 2017, SPSS Statistics for Data Analysis and Visualization, First Edition, Wiley.

**Web Resources**

1. https://www.tutorialspoint.com/excel_data_analysis/excel_data_analysis_tutorial.pdf
2. https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf

**Course Outcomes (COs) and Cognitive Level Mapping**

| DATA ANALYSIS USING MS EXCEL & SPSS (ME) | | Cognitive Level |
|---|---|---|
| CO 1 | To understand the Excel and SPSS packages and describing a variety of statistical variables and enter the data in the statistical Packages. | K1, K2 |
| CO 2 | To integrate and access the data base from different source of file format. | K3 |
| CO 3 | To analyse and apply the appropriate Charts and graphs and functions for the given data | K4 |
| CO 4 | To recommend the best statistical tool for basic statistical analysis. | K5 |
| CO 5 | To Apply statistical analysis that can test hypotheses under parametric and Non Parametric approaches | K6 |

| Course Code | UST 5602 |
|---|---|
| Course Title | R Programming |
| Credits | 06 |
| Hours/Week | 06 |
| Category | Major Elective (ME) - Lab |
| Semester | V |
| Regulation | 2019 |

**Course Overview:**

1. This course imparts knowledge on programming in R and the use of R for effective data analysis.

2. Installing and configuring R software necessary for a statistical programming environment

3. To describe generic programming language concepts as they are implemented in a high-level statistical language.

4. The course covers practical issues in statistical computing which includes programming in R, reading data into R, accessing R packages, writing R functions, debugging, profiling R code, and organizing and commenting R code.

5. Topics in statistical data analysis to be covered with working examples.

**Course Objective:**

1. To impart efficient Data Handling Techniques

2. To equip students with Statistical Programming Skills based on real life examples and datasets

3. To Understand critical programming language concepts

4. To Configure statistical programming software and Collect detailed information using R profiler

5. To learn how to ask the right questions, obtain data, and perform reproducible research.

| Prerequisites | Basic Knowledge of programming and basic Statistics |
|---|---|

| UNIT | CONTENT | Hours | CO's | COGNITIVE LEVEL |
|---|---|---|---|---|
| | **SYLLABUS** | | | |
| I | **Introduction to R and basic statistics**<br>Overview of R Environment – R editor – Workspace – Importing and Exporting Data - Data type – Matrix Determinant – Inverse – Transpose – Trace – Eigen Values and Eigen Vectors. Construction of Bar, Pie, Histogram, Line Chart, Box Plot, Scatter Plot | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| II | **Tabulation and Estimates**<br>Tabulation of categorical variable - Tabulation of continuous variable by forming class intervals - Cross tabulations - Maximum likelihood estimates and Confidence Intervals – Test of Goodness of fit. | 14 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| III | **Statistical Hypothesis Testing**<br>Parametric and Non Parametric testing of Statistical Hypothesis – One Sample t test – two group t test – paired t test – one way ANOVA- two way ANOVA – Latin Square Design – Sign Test – Wilcoxon – Mann Whitney – Kruskal Wallis tests | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| IV | **Regression model building**<br>Simple Correlation - Linear Regression – Multiple Linear Regression – Testing for overall significance of Model Coefficients – Testing for Individual Regression Coefficients – Outliers Detection – Dealing with Multicollinearity | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| V | **Construct Control Chart**<br>Time Series analysis – Reading – plotting time series data – Extract trend, Seasonality and Error – creates lags of time series – Auto correlation and Partial autocorrelation – de-trend and de-seasonalize – Testing Stationary | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Book:**

1. Randall Schumacker (2017), Learning Statistics using R, Sage Publication, 1st edition
2. Jared P.Lander (2017), R for Everyone, Pearson Education, 2ND Edition
3. Garrett Grolemund (2013), Hands on programming with R, O'Reilly, 1st edition
4. O'Reilly (2014), Learning R, O'Reilly, 1st edition

**Suggested Readings :**

1. R for data science : Import, Tidy, Transform, Visualize, And Model Data (2017) Hadley Wickham,  O'Reilly, 1st edition
2. The Book of R: A First Course in Programming and Statistics (2016), Tilman M. Davies, No Starch Press; 1st edition
3. R For Dummies (2015),  Andrie de Vries , John Wiley & Sons; 2nd edition.

**Web Resources:**

1. https://www.r-project.org/
2. **https://www.r-project.org/other-docs.html**
3. **https://www.rstudio.com/**
4. **https://scholar.harvard.edu/dromney/online-resources-learning-r**

## Course Outcomes (COs) and Cognitive Level Mapping

| COs | R Programming | Bloom's Level |
|-----|---------------|---------------|
| **CO1** | Understand the basics in R in terms of construct, control statements and string functions | K1, K2 |
| **CO2** | Perform various operations and apply common function to manipulate and analyze data using basic R syntax | K3 |
| **CO3** | Able to appreciate and apply the R programming from Statistical perspective | K4 |
| **CO4** | Visualize data attributes using ggplot and other Statistical packages | K5 |
| **CO5** | Apply R programming for data analytics and model building | K6 |

**Semester VI**

**COURSE DESCRIPTOR**

| Course Code | UST 6501 |
|---|---|
| Course Title | DESIGN AND ANALYSIS OF EXPERIMENTS |
| Credits | 06 |
| Hours/Week | 06 |
| Category | MC |
| Semester | VI |
| Regulation | 2019 |

**Course Overview**

1. This course introduces the basic concepts and principles of experimental design.
2. To Define objectives and obtain data to answer the underlying objectives,
3. To set response variable and the explanatory factors for the given objective.
4. To design the appropriate experiment for obtaining the relevant data.
5. To identify significant influencing factors on the outcome and interpret the results.

**Course Objectives**

1. To understand the basic terminology in experimental design.
2. To develop the students ability to plan an experiment.
3. Obtaining relevant information from the experiment in relation to the statistical hypothesis under study
4. To develop the skill of identifying important inputs that impact the output.

| Prerequisites | Basic knowledge in estimation theory and testing of hypothesis. |
|---|---|

| Unit | Content | Hours | Cos | Cognitive Level |
|------|---------|-------|-----|-----------------|
| | **SYLLABUS** | | | |
| I | Contrasts - linear constraints - orthogonal contrasts- testing for contrast - linear models - fixed effect model – random effect model - mixed effect model. | 14 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| II | Principles of experimentation - analysis of variance - one-way classification - two- way classification - two-way classification with more than one but equal number of observations per cell -ANOCOVA (Concept only) | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| III | Completely Randomised Design (CRD) - Randomised Block Design (RBD) - Latin Square Design (LSD) – Missing plot technique for RBD & LSD. Efficiency of R.B.D. relative to C.R.D and Efficiency of LSD Relative CRD, testing pair of means by using Tukey's test and Least significant difference (Lsd) test. | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| IV | Factorial designs: Terminology: Factors, levels, interactions, treatment combination, $2^2$, $2^3$ and $3^2$ factorial designs; confounding: Total and Partial. | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| V | BIBD: Definition, Parameters of BIBD and their relationships, Incidence Matrix, Symmetric BIBD, Intra block analysis of BIBD. Construction of BIBD (Simple construction). | 16 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

| Text Books |
|---|
| 1. Gupta S.C and Kapoor V.K., 2007, Fundamentals of Applied Statistics, Revised Edition, Sultan Chand & Son. |
| 2. Montgomery, D.C, 2013, Design and Analysis of Experiments, Eighth Edition, John Wiley & Sons. |

| Suggested Readings |
|---|
| 1. Das M.N. and Giri N., 2017, Design and Analysis of Experiments, Third Edition, New Age International. |
| 2. D. D. Joshi, 1987, Linear Estimation and Design of Experiments, New Age International Private Limited. |

| Web Resources |
|---|
| 1. http://home.iitk.ac.in/~shalab/anova/chapter4-anova-experimental-design-analysis.pdf |
| 2. https://www.itl.nist.gov/div898/handbook/pri/section3/pri3.htm |

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 6501- DESIGN AND ANALYSIS OF EXPERIMENTS (MC) | | Cognitive Level |
|---|---|---|
| CO 1 | To understand the basic concepts and principles of experimental designs and recall the concept of estimation theory and testing of hypothesis. | K1, K2 |
| CO 2 | To Identify the factors and variable for the experiment for building statistical model. | K3 |
| CO 3 | To Analyze the various design of experiment concepts and missing plot techniques. | K4 |
| CO 4 | To explain the ANOVA results interpret the key variables that influence the response variables. | K5 |
| CO 5 | To Construct suitable designed experiment for a given real life data. | K6 |

# COURSE DESCRIPTOR

| Course Code | UST 6502 |
|---|---|
| Course Title | OPERATIONS RESEARCH |
| Credits | 06 |
| Hours/Week | 06 |
| Category | Major Core (MC) - Theory |
| Semester | VI |
| Regulation | 2019 |

**Course Overview**

1. Operations Research is a systematic and scientific approach to seek solutions to decision-making problems.

2. This course attempts to locate the best or optimal solution to the problem under consideration.

3. It tells about how to formulate a real life problem as a mathematical problem, solve it using mathematical techniques and interpret the solution in terms of the real life problem.

4. This course is of a multi-disciplinary nature involving the areas of mathematics, statistics, management and computer science.

**Course Objectives**

1. To impart knowledge on how to formulate a real –life problem in a mathematical form and find a criterion for solving it.

2. Choose the best (optimal) alternative among the available alternative courses of action.

3. To explore various techniques available in Operations Research.

4. Apply the techniques in different areas such as transportation, production and marketing.

| Prerequisites | Basic Knowledge of Mathematics, Statistics and Computers. |
|---|---|

## SYLLABUS

| Unit | Content | Hours | Cos | Cognitive Level |
|------|---------|-------|-----|-----------------|
| I | Introduction to OR – Linear programming problem – Formulation – Graphical method – Basic solution – Optimum solution – Simplex method – Various cases – Un bounded solution – Unrestricted variables, alternative optimum. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | Need for artificial variables – Two phase method – Big M method – Primal, Dual relationship – Dual simplex method. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | Transportation problem – North-west corner rule – Least cost method – Vogel's approximation method – Modified method, Assignment problem – Balanced and Unbalanced. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | Networks – CPM and PERT – problems. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | Games – Two person zero sum games – Saddle point – Solving by graphical method – Principle of Dominance - solving by LPP – Simulation – Monte-Carlo simulation. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books**

1. Gupta, P.K. and Man Mohan (1979) Linear Programming and Theory of Games, Sultan Chand & Sons, New Delhi, 3rd Edition.

2. Hamdy A. Taha (2011) Operation Research – An introduction, Macmillan Publishers, 9th Edition.

3. Kanti Swarup, Gupta, P.K. and Man Mohan (2012) Operations Research, Sultan Chand & Sons, New Delhi, 16th Edition.

4. Sharma, J. K. (2007) Operations Research, Theory and applications, Macmillan Publications, India, 3rd Edition.

**Suggested Readings**

1. Don T. Philips, Ravindran, A., and James J. Solberg (2007) Operation Research: Principles and Practices, John Wiley & sons, 2nd Edition.

2. Hadley (2006) Linear Programming, Wesley publishers, 1st Edition.

3. Hillier, F.S. and Lieberman, G.J. (2017) Introduction to Operations Research, Holden day publishing, San Francisco, 10th Edition.

4. Hillier, F.S., Lieberman, G.J., Bodhibrata Nag, Preetam Basu, (2012) Introduction to Operational Research, Tama McGraw Hill Ltd., New Delhi.

5. Kothari, C. R. (2009) An Introduction to Operational Research, Vikas Publishing house Pvt. Ltd., 3rd Edition.

6. Sharma, S. D. (2014) Operations Research – Theory, Methods and Applications, Kedar Nath Ram Nath.

7. Srinivasan, G. (2010) Operations Research: Principles and Applications, Prentice Hall of India, e-Book.

8. Mariappan, P. (2013) Operations Research: An Introduction, Pearson, e-book,1st Edition.

**Web Resources:**

1. https://www.classcentral.com/course/swayam-operations-research-14219

2. https://onlinecourses.nptel.ac.in/noc19_ma29/preview

3. https://www.edx.org/course/operations-research-an-active-approach

4. https://www.nptel.ac.in/noc/courses/noc17/SEM1/noc17-mg10/

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 6502 - OPERATIONS RESEARCH (MC) | | Cognitive Level |
|---|---|---|
| **CO 1** | To understand the principles of linear programming problems, theory of games and network analysis. | K1, K2, |
| **CO 2** | To compute optimal solutions of linear programming problems, find optimal strategies to win a game and optimal schedule of a given project by suitable algorithms. | K3 |
| **CO 3** | To analyse the optimization techniques of linear programming, theory of games and network analysis in solving real world problems. | K4 |
| **CO 4** | To evaluate the concepts in linear programming and game theory and to estimate the optimal schedule of a project. | K5 |
| **CO 5** | To design a mathematical model for an optimization problem in real life by adopting the techniques of operations research. | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 6503 |
|---|---|
| Course Title | STATISTICAL QUALITY CONTROL |
| Credits | 6 |
| Hours/Week | 6 |
| Category | Major Core (MC) – Theory |
| Semester | VI |
| Regulation | 2019 |

**Course Overview**

1. This course seeks to provide an understanding of modern business environment and Statistical and Philosophical thoughts for quality improvement.
2. It helps to identify process variation through data visualization techniques.
3. It exposes various control charts to diagnose and improve process quality
4. This course helps to understand the Cumulative sum control chart, Slant control chart and Process Capability Analysis.
5. It explains the concepts of acceptance sampling plan in quality assurance.

**Course Objectives**

1. To understand the quality improvement using statistical methods and Total Quality Management tools.
2. To explore knowledge on process quality through data visualization.
3. To implement Process Control using variable and attribute control charts.
4. To appreciate the use of sampling plans for quality control.

| | |
|---|---|
| **Prerequisites** | Basic knowledge in Statistics, Mathematics and Computer skills |

| UNIT | CONTENT | HOURS | COs | COGNITIVE LEVEL |
|------|---------|-------|-----|-----------------|
| | **SYLLABUS** | | | |
| I | Quality improvement in the modern business environment: Philosophy and basic concepts of quality improvement - Statistical methods for quality improvement - Total Quality Management (TQM). | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | Modeling process quality: Describing variation - Histogram, Stem and Leaf plot, Box plot, Frequency distributions, Quantile plot (qq-plot) applications. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | Statistical Process Control (SPC): Methods and philosophy of SPC - Control charts for attributes data - p chart, np chart, c and u charts and D chart - Control charts for variables - X and R charts, X and S charts - Applications. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | 4 Basic principles of CUSUM and slant control charts - process capability analysis - Applications. | 12 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | Acceptance sampling: The acceptance sampling problem - Single sampling plan for attributes with applications - Basic concepts of double, multiple and sequential sampling plans - Concept of CSP. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

| Text Books |
| --- |
| 1. Montgomery, D.C. (2007), Introduction to Statistical Quality Control (Third Edition), John Wiley and sons Inc. |
| 2. Duncan, A.J. (2010), Quality Control and Industrial Statistics (Fourth Edition), Irwin, Homewood, Ill. |

| Suggested Readings |
| --- |
| 1. Forrest W. Breyfogle III(1999)- implementing six sigma: smarter solutions using statistical methods, john Wiley and Sons, Inc. |
| 2. Schilling, E.G. (1982), Acceptance Sampling in Quality Control, Marcel Dekker Inc., N.Y. |
| 3. Grant, E.L. and Leavenworth, R.S. (1980), Statistical Quality Control (Fifth Edition), McGraw Hill, New York. |

| Web Resources |
| --- |
| 1. http://bmepedia.weebly.com/uploads/2/6/6/8/26683759/unit_4_quality_control.pdf |
| 2. http://www.gdcboysang.ac.in/About/droid/uploads/contents%20of%20UNIT%20iii-part%20%20A.pdf |
| 3. https://www.youtube.com/watch?v=E2JCHsi8knA |
| 4. http://ndl.ethernet.edu.et/bitstream/123456789/78721/2/Lecture%20Note%20Statistical%20Quality%20Control%20.pdf |

| UST 6503 – STATISTICAL QUALITY CONTROL | | Cognitive Level |
| --- | --- | --- |
| CO 1 | To understand the Quality control and improvement using Statistical techniques and Philosophical thoughts. Describing variations through charts and diagrams | K1, K2 |
| CO 2 | To determine the variation level of process using control charts techniques. | K3 |
| CO 3 | To inspect the quality control for Variables and attributes control charts. | K4 |
| CO 4 | To evaluate the process standard and recommend solution for the given problem. | K5 |
| CO 5 | To apply Control charts and sampling plans in real life | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 6706 |
|---|---|
| Course Title | PYTHON FOR STATISTICS |
| Credits | 6 |
| Hours/Week | 6 |
| Category | MS |
| Semester | VI |
| Regulation | 2019 |

**Course Overview**

1. This course helps to understand Python environment and import and export of datasets.
2. It helps to know the fundamentals of Python through statements, data types, operators, conditional and functions.
3. This course is designed to bring out diagrammatic representations leading to a clear analysis of data.
4. It helps to model the relationships among variables using large data sets.
5. It enables implementation of various tests of hypotheses under parametric and non-parametric settings.

**Course Objectives**

1. To understand Python environment, Python Packages and data types.
2. To comprehend knowledge on Python fundamentals like commands and statements, I/O statements, Operators and function and arguments.
3. To model the relationship between variables and visualize features present in the data through diagrammatic representation.
4. To carry out parametric tests and non-parametric tests.

| Prerequisites | Basic knowledge in Statistics and Computer skills |
|---|---|

| UNIT | CONTENT | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Introduction to Python – Origin of Python, why use of Python, Benefits of Python. Creating Python Platform. Interactive Development Environment – Setting working directory, packages, Import and Export of Excel, CSV files. | 12 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | Python fundamentals – Statements, comments, indentation, Assigning variables, data types, input and output statements. Mathematical and statistical operators, conditional statements, loop statements, methods and arguments. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | Diagrammatic representation – simple bar diagram, Multiple bar diagram, subdivided bar diagram, Pie diagram, Scatter plot, Histogram, Box plot. Measures of central tendency, Measure of dispersion. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | Simple Correlation - Linear Regression – Multiple Linear Regression-Logistic Regression- Dealing with Multicollinearity | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | Parametric testing of Statistical Hypothesis – One Sample t test – independent sample t test – paired t test – one way ANOVA- two way ANOVA. Non-Parametric testing of Statistical Hypothesis - Sign Test – Wilcoxon – MannWitney – Kruskal Wallis. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books**

1 Chun, W.J. (2012) Core Python Programming, Pearson, III Edition
2 Ossama Embarak (2018), Data Analysis and Visualization using Python

**Suggested Readings**

1. Rance D. Necaise (2018), Data Structures and Algorithms using Python, Wiley Student Edition
2. Donaldson, T (2014) Visual Quick start Guide Python, Pearson, 3rd Edition

**Web Resources**

1. https://www.tutorialspoint.com/python/index.htm
2. https://www.geeksforgeeks.org/data-visualization-different-charts-python/
3. https://docs.python.org/3/tutorial/
4. https://www.geeksforgeeks.org/linear-regression-python-implementation/
5. https://machinelearningmastery.com/statistical-hypothesis-tests-in-python-cheat-sheet/

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 6706 PYTHON FOR STATISTICS | | Cognitive Level |
|---|---|---|
| CO 1 | To describe the basic programming skills using Python Language. Discuss variations kinds of data using import and export commands. | K1, K2 |
| CO 2 | To produce essential conclusion in real life scenario applying python programming language. | K3 |
| CO 3 | To Experiment the python programming language along with statistical tools in various domains. | K4 |
| CO 4 | To measure the amount of relationship of variables in order to validate the quality of work. | K5 |
| CO 5 | To develop Product using python programming to give solution in new way or customised way. | K6 |

**COURSE DESCRIPTOR**

| Course Code | UST 2301 |
|---|---|
| Course Title | BUSINESS STATISTICS |
| Credits | 3 |
| Hours/Week | 6 |
| Category | ALLIED REQUIRED (AR) |
| Semester | II |
| Regulation | 2019 |

**Course Overview:**

1. Business Statistics includes descriptive statistics, correlation and regression, time series forecasting and some optimizing techniques.

2. This course imparts basic understanding about data and its relevance in business.

3. The course covers statistical techniques which are commonly used in business context.

4. This course includes ideas which are required for learning and do research on various socio-economic and finance issues.

5. Business Statistics introduces fundamental aspects of decision-making.

**Course Objectives:**

1. To introduce basic statistical concepts related to business applications.

2. To summarize and critically analyse business data.

3. To provide statistical techniques for business data analysis.

4. To impart the knowledge of statistical tools for drawing meaningful inferences.

| Prerequisites | Basic Mathematical Concepts |
|---|---|

| | **SYLLABUS** | | | |
|---|---|---|---|---|
| **Unit** | **Content** | **Hours** | **Cos** | **Cognitive Level** |
| **I** | Measures of Central tendency: Simple averages – mean, median and mode –Geometric mean and Harmonic mean – weighted arithmetic mean. Measures of Dispersion: Range – Quartile deviation – mean deviation – Standard deviation – coefficient of variation – Combined mean and standard Deviation. Skewness: Karl Pearson and Bowley's Coefficient of skewness – Moments – Kurtosis. | 15 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **II** | Curve fitting: Fitting a straight line and second-degree parabola. Correlation: Scatter diagram – Limits of correlation coefficient – Spearman's Rank correlation coefficient – Simple problems. | 12 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **III** | Time series: components of time series, additive and multiplicative models, Measurement of trend-graphical method. Semi average method, moving average method, Time Series: Components of time series-Additive and multiplicative models – Measurement of trend – Graphical method -Semi-average method-moving average method-least squares method. Measurement of Seasonal Variation –Method of Simple averages – ratio-to trend method – ratio to moving average method-method of link relatives. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **IV** | Introduction to Regression- Mathematical and Statistical Equation- Meaning of intercept and Slope. Error Term-Measure for model fit- $R^2$-MAE-MAPE. Multiple Linear Regression Model – Logistic Regression. | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **V** | Elements of Operation Research: Linear Programming – Solving L.P.P. by Graphical method – Transportation problems – North-West corner rule – Least cost method - Vogel's Approximation Method – Optimal solution using Modi method | 17 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

| Text Books |
|---|
| 1. Vittal, P.R.(2010) Business Statistics. Margham Publications, Madras |
| 2. Gupta, S.P. (2011), Statistical Methods-Sultan Chand and Sons Publishers. New Delhi. |
| 3. Yule and Kendall (1993).Introduction totheory of Statistics. Universal Book Stall, New Delhi. |
| 4. Croxton and Cowden (1956).Applied General Statistics.Sir Isaac Pitman and Sons. Ltd., London. |
| 5. Gupta,S.C. and Kapoor,V.K. (2002). Fundamentals of Mathematical Statistics. Sultanchand and Sons. New Delhi |
| 6. Taha,H.A. (1997). Operations Research. Macmillan Publishing Housing Co., New Delhi. |

| Suggested Readings |
|---|
| 1. Gupta M.P. and Gupta S.P. (2019). Business Statistics, Sultan Chand and Sons Pvt. Ltd,New Delhi. |
| 2. Gupta S.C. and Kapoor V.K. (2009) Fundamentals of Applied Statistics, Sultan Chand and Sons Pvt. Ltd, New Delhi. |
| 3. Philip Bobko (2002). Correlation and Regression: Applications for Industrial Organizational Psychology and Management, Sage Publications Inc. |
| 4. Arumugam S. and Thangapandi Isaac A. (2007). Statistics, New Gamma publishing House. |
| 5. Kanti Swarup, Gupta, P.K. and Man Mohan (1996), Operations Research, sSultan Chand and Sons (P) Ltd., New Delhi |

| Web Sources |
|---|
| 1. http://eagri.org/ |
| 2. http://egyankosh.ac.in/ |
| 3. http://nsdl.niscair.res.in/ |

## COURSE OUTCOMES (COs)

| UST 2301 - BUSINESS STATISTICS (AR) | | Cognitive Levels |
|---|---|---|
| CO 1 | Understand and present data meaningfully | K1, K2 |
| CO 2 | Apply summary measures of averages and dispersion to draw useful conclusions | K3 |
| CO 3 | Statistically analyze the strengths of relationship between variables. | K4 |
| CO 4 | Evaluate real-life problems and make decisions | K5 |
| CO 5 | Construct suitable statistical models to forecast various business-related problems | K6 |

## COURSE DESCRIPTER

| Course Code | UST 2302 |
|---|---|
| Course Title | MATHEMATICAL STATISTICS |
| Credits | 3 |
| Hours/Week | 6 |
| Category | AR |
| Semester | II |
| Regulation | 2019 |

**Course Overview:**

1. The course discusses the basic statistical concepts in random variables, discrete and continuous distributions.
2. To develop a theoretical understanding of random variables, expectation and joint probability function.
3. The course provides students the knowledge on application of discrete and continuous distributions.
4. To learn the basic ideas of sampling distributions and order statistics.

**Course Objective:**

1. To impart statistical concepts and results with rigorous mathematical treatment.
2. To introduce fundamental concepts such as random variables, discrete, continuous distributions and sampling distributions.
3. To enrich knowledge on the real-life applications of Statistics.
4. To learn the general theory of statistical distributions as well as the standard distributions used in statistical practice.
5. To understand sampling distributions and order statistics and their applications.

| Prerequisite: | Calculus, Probability |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **CO's** | **COGNITIVE LEVEL** |
| I | **Random Variables:** (Discrete and continuous), Distribution function – Expectation and moments Moment generating function – probability generating function – Examples. Chebychev's inequality Bivariate Distribution – Marginal – Conditional distribution – Correlation Coefficient. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| II | **Discrete distributions:** uniform, Binomial, Poisson, Negative Binomial, Hyper geometric and geometric distributions- Properties and simple problems | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| III | **Continuous distributions:** Normal and Uniform distributions, Exponential, Gamma and Beta first and second kind distributions, Transformation of random variables. | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| IV | **Sampling distributions:** P. d. f. of t, $\chi 2$, F- Properties of sampling distributions- relationship between sampling distributions – simple problems | 16 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| V | **Order Statistics** — Sample mean – Sample variance – distributions. Central limit theorem – Examples. | 14 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Book:**

    1. Hogg R. V. & Craig A. T. 1988) : Introduction to Mathematical Statistics, Mcmillan.

**Suggested Readings :**

1. Gupta. S.C. & Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics , Sultan Chand & Sons Pvt. Ltd. New Delhi

2. Mood A. M & Graybill F. A & Boes D. G (1974) : Introduction to theory of Statistics, Mcgraw Hill.

Web Resources:

1. https://www.khanacademy.org/math/statistics-probability
2. https://youtu.be/a55zaWVWYhM
3. https://youtu.be/iRguN9WkYTI
4. https://youtu.be/TqM0oUJM2XM
5. https://youtu.be/TqM0oUJM2XM

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 2302 - MATHEMATICAL STATISTICS | | Cognitive Level |
|---|---|---|
| **CO1** | Recall the basic concepts in probability and statistics and Illustrate the different aspects of mathematical expectation. | K1, K2 |
| **CO2** | Calculate the expected value, moments <br> Explain and successfully apply the Central Limit Theorem and Chebychev's inequality | K3 |
| **CO3** | Discuss the discrete and continuous probability distributions and solve the problems related to discrete and continuous probability distributions | K4 |
| **CO4** | Apply sampling distributions of means and variances and the t- and F-distributions | K5 |
| **CO5** | Formulate distribution functions, probability mass functions and density functions | K6 |

# COURSE DESCRIPTOR

| Course Code | UST 3401 |
|---|---|
| Course Title | **PYTHON PROGRAMMING** |
| Credits | **3** |
| Hours/Week | **5** |
| Category | **AO** |
| Semester | **III** |
| Regulation | **2019** |

**Course Overview:**

1. This course is designed to introduce the fundamentals of Python programming language for students without prior programming experience.

2. Students are introduced to core programming concepts like data frame, conditionals, loops, variables, and functions.

3. This course includes an overview of the various tools available for writing and running Python, and gets students coding quickly.

4. Python programming provides hands-on coding exercises.

5. The focus of the course is to provide students with an introduction to programming, visualization and data analysis using the Python programming language.

**Course Objective:**

1. Install and run the python Interpreter
2. Create and execute python programs
3. Understand the concept of data types, input and output files
4. Plot data using matplotlib to visualize the data
5. Analyse various univariate and bivariate data.

| Prerequisites | Basic Knowledge of Statistics and Computer Science |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **UNIT** | **CONTENT** | **HOURS** | **CO's** | **COGNITIVE LEVEL** |
| **I** | Introduction to Python – Origin of Python , Why use of Python, Benefits of Python. Creating Python Platform. Interactive Development Environment – Setting working directory, packages, Import and Export of Excel, CSV files. | 13 | CO1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **II** | Python fundamentals – Statements, comments, indentation, Assigning variables, data types, input and output statements. | 13 | CO1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **III** | Mathematical and statistical operators, conditional statements, loop statements, methods and arguments. | 13 | CO1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **IV** | Diagrammatic representation – simple bar diagram, Multiple bar diagram, subdivided bar diagram, Pie diagram, Scatter plot, Histogram, Box plot. | 13 | CO1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **V** | Measures of central tendency, Measure of dispersions, correlation, regression and chi-square tests. | 13 | CO1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Book:**

1. Chun, W.J. (2012), Pearson, III Edition, Core Python Programming.
2. Ossama Embarak (2018), Apress, Data Analysis and Visualization using Python

**Suggested Readings:**

1. Rance D. Necaise (2018), Wiley student Edition, Data structures and Algorithms using python.
2. Donaldson, T (2014), Pearson, III Edition, Visual Quick start Guide Python.

**Web Resources:**

1. https://www.coursera.org/specializations/statistics-with-python
2. https://scipy-lectures.org/packages/statistics/index.html
3. https://youtu.be/mQ-3KwrBIN0
4. https://youtu.be/YCPYNXtwKAc

### Course Outcomes (COs) and Cognitive Level Mapping

| UST 3401 Python Programming | | Cognitive Level |
|---|---|---|
| **CO1** | Remembering the concept of operators, data types, looping statements in python programming. | K1, K2 |
| **CO2** | Understanding the concept of Input/Output operations in file. | K3 |
| **CO3** | Acquire the knowledge of Import and Export of Excel, CSV files. Learn the fundamentals of some of the most widely used Python packages and apply them in Data Analysis and Data Visualization. | K4 |
| **CO4** | Analysing the structures of list, tuples, set and dictionaries. | K5 |
| **CO5** | Design graphical representation of data and build linear regression model using matplotlib and scipy import stats. | K6 |

# COURSE DESCRIPTOR

| Course Code | UST 3801 |
|---|---|
| Course Title | BASIC STATISTICS |
| Credits | 02 |
| Hours/Week | 03 |
| Category | NME |
| Semester | III |
| Regulation | 2019 |

**Course Overview**

1. This course introduces basic statistics and fundamental aspects of decision-making.
2. This statistics course introduces the basic concepts of statistical analysis, with a focus on both univariate and bivariate data.
3. The course starts with basic ideas of statistics and then moves on to organization and display of data.
4. Analysis of univariate data by way of measures of central tendency, dispersion and asymmetry.
5. Students will be provided with the statistical concepts, tools and methods of statistics as well as the opportunity to work through example problems.

**Course Objectives**

1. To understand the basic concepts of statistics.
2. To develop the ability to deal with numerical and quantitative issues in relevant field.
3. To enable the use of statistical, graphical and algebraic techniques wherever relevant.
4. To analyze relationship between factors and quantify the same,

| | |
|---|---|
| **Prerequisites** | Basic knowledge in Statistics. |

| | | SYLLABUS | | | |
|---|---|---|---|---|---|
| **Unit** | **Content** | **Hours** | **Cos** | **Cognitive Level** |
| **I** | Introduction: Definition, Functions, Scope and Limitations. Collection of Data: Method of collecting primary and secondary data. | 8 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **II** | Classification of data: Methods of classification. Tabulation of Data: One-way and Two-way tables. | 7 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **III** | Diagrammatic representation of data: One – dimensional and Two dimensional diagrams. Graphical representation of data: Frequency curve, Cumulative frequency curves. | 8 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **IV** | Measures of Location: Arithmetic Mean, Median, Mode. Measures of spread: Range, mean deviation, standard deviation and co efficient of variation. | 8 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |
| **V** | Correlation: Types of Correlation: Methods of finding correlation co efficient: Simple correlation - Rank correlation-Properties of correlation co efficient. | 8 | CO 1 CO 2 CO 3 CO 4 CO 5 | K1 K2 K3 K4 K5 K6 |

**Text Books**

1. S.P.Gupta, 2019, Statistical Methods, 5th Edition, Sultan Chand &Sons,
   New Delhi.

**Suggested Readings**

1. S.C.Gupta &V.K.Kapoor, 2017, Fundamentals of Mathematical Statistics, 11th Edition, Sultan Chand &Sons, New Delhi.

2. Kapoor.J.N & Saxena.H.C, 1976, Mathematical Statistics, 8th Edition, Sultan Chand & Sons, New Delhi.

**Web Resources**

1. https://pdfread.link/download/statistical-methods-by-sp-gupta-pdf

2. https://pdfcoffee.com/business-statistics-by-s-p-gupta-pdf-free.html.

3. https://www.academia.edu/31552250/fundamentals_of_mathematical_statistics

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 3801 - Basic Statistics | | Cognitive Level |
|---|---|---|
| CO 1 | To define the basic concepts and elements of statistics | K1, K2 |
| CO 2 | To identify the method of collecting primary and secondary data. | K3 |
| CO 3 | To apply suitable diagrams for presenting data. | K4 |
| CO 4 | To summarize data through measures of location and spread | K6 |
| CO 5 | To analyze the type of relationship between factors. | K4, K5 |

## COURSE DESCRIPTOR

| Course Code | UST 4401 |
|---|---|
| Course Title | PROBABILITY AND DISTRIBUTIONS |
| Credits | 03 |
| Hours/Week | 05 |
| Category | AO |
| Semester | IV |
| Regulation | 2019 |

**Course Overview**

1. The course covers the foundations of probability theory including: probability laws, conditional probability, addition and multiplication theorems and Baye's theorem of probability.
2. The aim of the course is to give basic knowledge about random variables, expectation and joint probability functions.
3. This course helps the students to gain knowledge in applications of discrete and continuous probability distributions.
4. The course exposes the basic concepts of stochastic processes, Markov chains and Transition probability matrix.

**Course Objectives**

1. The main objective of this course is to provide students with the foundations of Probability, Random variables, Distributions and Stochastic processes.
2. To help students understand the basic notions about random variables, marginal and joint distributions.
3. To identify the type of statistical situation to which different distributions can be applied.
4. To develop an ability to analyze and apply some basic stochastic processes for handling real life situations.

| Prerequisites | Basic knowledge in Statistics and Mathematics |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| UNIT | CONTENT | HOURS | Cos | COGNITIVE LEVEL |
| I | Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic approach. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications. | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| II | Random variables: Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations, Joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables with illustrations. Moments, Moment generating function | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| III | Discrete Distributions: Uniform, Binomial, Poisson, Geometric, Negative Binomial and Hyper-geometric distributions | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| IV | Continuous Distributions: Normal, Exponential, Uniform, Gamma – Properties. Simulation from Continuous distributions | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| V | Stochastic Process: Definition- Classification – Markov chain –Random walk - Markov process – Poisson process – Brownian motion (Basic concepts only) | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Books**

1. Hogg R. V. & Craig A. T., 1988, Introduction to Mathematical Statistics, 4th Edition, Macmillan Publishing Co., Inc. New York.

2. Karlin, S and H.M. Taylor, 1966, A First course in Stochastic process, 2nd Edition, Academic Press, New York.

**Suggested Readings**

1. S.C.Gupta &V.K.Kapoor, 2017, Fundamentals of Mathematical Statistics, 11th Edition, Sultan Chand &Sons, New Delhi.

2. Mood A. M., Graybill F. A & Boes D. G, 1974, Introduction to Theory of Statistics, 3rd Edition, McGraw Hill.

**Web Resources**

1. https://fac.ksu.edu.sa/sites/default/files/hogg_craig_introduction_to_mathematical_statistics_4th_edition1.pdf.

2. http://sistemas.fciencias.unam.mx/~misraim/Mood.pdf.

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 4401 - Probability and Distributions | | Cognitive Level |
|---|---|---|
| CO 1 | To understand the basic concepts and results of probability theory in real-life situations | K1, K2 |
| CO 2 | To evaluate the characteristics of joint and marginal distributions | K3 |
| CO 3 | To explain the mathematical expectation and moments and solve the problems related to discrete and continuous random variables. | K5 |
| CO 4 | To apply various discrete and continuous distributions and their applicability to describe real-world data | K4 |
| CO 5 | To execute the concepts of stochastic process and reliability theory in the fields of physics | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 4402 |
|---|---|
| Course Title | **STRUCTURED QUERY LANGUAGE** |
| Credits | **03** |
| Hours / Week | **05** |
| Category | **Allied Optional(AO) – Lab** |
| Semester | **IV** |
| Regulation | **2019** |

**Course Overview:**

1. SQL (Structured Query Language) is a programming language used for managing data in relational database.
2. This course covers creation of Database, Tables, and Creation of variables by specifying variable type.
3. Creation of new variables using arithmetic operators, Numeric functions, character functions and date functions.
4. Subsetting tables based on AND, OR, Exact matches and Fuzzy match based conditional statements. Ordering tables.
5. Aggregating tables using Group by statement. Stacking and Merging tables

**Course Objective:**

1. To impart the concept of Relational Database
2. To illustrate creation of Database and Tables
3. To explore SQL queries for variable creation, Subsetting, ordering, aggregating and merging tables.
4. To encourage Students to take up future learning in the area of Big Data.

| **Prerequisites:** | Basic Computer Literacy, Basic Data manipulation on Structured Data (MS Excel) and data storage in Flat Files. |
|---|---|

| | SYLLABUS | | | |
|---|---|---|---|---|
| **Unit** | **Content** | **Hours** | **Co's** | **Cognitive Level** |
| I | Introduction to SQL- Data types –Data Definition Language – Data Manipulation Language – Transactional Control Language. | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| II | Operators: Arithmetic Operators: – Logical Operators: AND –OR-NOT. Relational Operators: Special Operators: LIKE-BETWEEN-AND –IN – ANY-ALL. String Operators. | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| III | Built in-Functions: Character Functions –-CHR - CONCAT– INITCAP-LOWER-LTRIM-RTRIM. SUBSTR-ASCII-LENGTH- Numeric Functions: ABS-CEIL-FLOOR –COS-MOD-POWER- Date Functions – Date Arithmetic Functions – Conversion Functions – Aggregate functions. | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| IV | Introduction to SELECT statement: Using WHERE clause – Working with Null Values – Order by Clause – Group by and Having Clause . | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| V | Sub Query: Sub- query returning one row-Sub-query returning more than one row –Correlated Sub – query.Joins: Cartesian Join – Equi Join – Self Join – Outer Join. Set operators : Intersect – Union – Union All – Minus. | 13 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Books**

1. Learning MySQL, Hugh Williams, Saied Tahaghoghi, O'Reilly Media, 2009, Edition I
2. SQL Primer, Rahul Batra, Apress, 2018, Edition I

**Suggested Readings**

1. Learn PostgreSQL, Luca Ferrari, Enrico Pirozzi, Packt publication, Edition I
2. Instant PostgreSQL Starter, Daniel K.Lyons, Packt Publication, Edition I

**Web Resources**

1. https://www.w3schools.com/MySQL/default.asp
2. https://www.mysqltutorial.org/
3. https://www.postgresqltutorial.com/
4. https://www.postgresql.org/docs/current/tutorial.html

## Course Outcomes (COs) and Cognitive Level Mapping

| UST 4402 – STRUCTURED QUERY LANGUAGE | | Cognitive Level |
|---|---|---|
| CO1 | Define and understand the concept of Relational Database and to create Database and Tables. | K1, K2 |
| CO2 | Identify and Apply the different operators in various problems. | K3 |
| CO3 | Identify the appropriate Numeric, Character and Date functions and Apply on the tables. | K4 |
| CO4 | Choose appropriate clause such as where clause, order by, and group by having clauses and sort the records in the tables. | K5 |
| CO5 | Develop skills to write querying the tables Acquainted with the different concepts of Joins functions. | K6 |

## COURSE DESCRIPTOR

| Course Code | UST 4801 |
|---|---|
| Course Title | DATA ANALYSIS USING SPSS |
| Credits | 02 |
| Hours/Week | 03 |
| Category | NME |
| Semester | IV |
| Regulation | 2019 |

**Course Overview**

1. This course gives application-oriented introduction to the statistical component of SPSS.
2. Students understand the SPSS software to handle Data
3. Students learn how to import different file format into SPSS.
4. Students explore the various graphs, charts and basic statistical techniques in SPSS.
5. Students will apply appropriate statistical tool for given data set and give the interpretation.

**Course Objectives**

1. To understand how to start SPSS and define a variety of statistical variables.
2. To Gain hands-on experience undertaking common data management steps in SPSS.
3. To perform statistical analysis, selecting the most appropriate techniques and methods for collecting and processing statistical data.
4. To interpret the SPSS outputs and acquiring critical thinking towards conclusions based on statistical studies.

| Prerequisites | Basic knowledge in descriptive statistics concepts. |
|---|---|

| | | SYLLABUS | | | |
|---|---|---|---|---|---|

| Unit | Content | Hours | Cos | Cognitive Level |
|---|---|---|---|---|
| **I** | Introduction to SPSS – Setting up the spss platform – Data entry, coding the categorical variables – recode, compute, transform, merge functions.  Import and Export Excel files. | 8 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **II** | Table presentation – Frequency table, two way table, three way table, n-way table. | 8 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **III** | Data visualization – Bar diagrams- Pie Diagram – Multidimensional view diagram - Histogram – Scatter diagram – Box plot. | 8 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **IV** | Descriptive Statistics – Measure of central tendency - measure of dispersion -Skewness-Kurtosis. | 8 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |
| **V** | Correlation – Karl Pearson's and Spearman's Rank Correlations , Simple Regression. | 7 | CO 1<br>CO 2<br>CO 3<br>CO 4<br>CO 5 | K1<br>K2<br>K3<br>K4<br>K5<br>K6 |

**Text Books**

1. Andy Field., 2000, Discovering Statistics using SPSS for Windows, SAGE Publications. Sabine Landau &Everitt, B.S., 2003, A Handbook of Statistical Analyses using SPSS, Taylor & Francis.

**Suggested Readings**

1. Foster, J. J, 2001, Data Analysis using SPSS for Windows Versions 8 to 10, First New Ed., SAGE Publications, New Delhi.
2. William E. Wagner III, 2009, Using SPSS for Social Statistics and Research Methods, II Ed., Pine Forge Press.

**Web Resources**

1. https://www.westga.edu/academics/research/vrc/assets/docs/spss_basics.pdf
2. https://students.shu.ac.uk/lits/it/documents/pdf/analysing_data_using_spss.pdf

**Course Outcomes (COs) and Cognitive Level Mapping**

| UST 4801 - DATA ANALYSIS USING SPSS (NME) | | Cognitive Level |
|---|---|---|
| CO 1 | To Understand how to create a database in SPSS, including entering survey/questionnaire data. | K1, K2 |
| CO 2 | To integrate and manage the database in SPSS | K3 |
| CO 3 | To analyse and apply the appropriate diagrams, statistical charts and graphs. | K4 |
| CO 4 | To recommend the best statistical tool for basic statistical analysis. | K5 |
| CO 5 | To Apply Statistical technique with confidence and interpret the output. | K6 |

# CL AND CO BASED CIA QUESTION PAPER FORMAT FOR UG THEORY COURSES MC, AR, AO, MS, ME, GL and NME*
## (Excluding other languages)

| SECTION | MARKS | Q. NO | K1 | K2 | K3 | K4 | K5 | K6 |
|---------|-------|-------|----|----|----|----|----|----|
| A | Answer ALL (6 x 1 = 6) | 1 | + | | | | | |
| | | 2 | + | | | | | |
| | | 3 | + | | | | | |
| | | 4 | | + | | | | |
| | | 5 | | + | | | | |
| | | 6 | | + | | | | |
| B | Answer 1 out of 2 (1 x 6 = 6) | 7 | | | + | | | |
| | | 8 | | | + | | | |
| C | Answer 1 out of 2 (1 x 6 = 6) | 9 | | | | + | | |
| | | 10 | | | | + | | |
| D* | Answer 1 out of 2 (1 x 12 = 12) | 11 | | | | | + | |
| | | 12 | | | | | | + |
| No. of CL based Questions with Max. marks | | | 3 (3) | 3 (3) | 1 (6) | 1 (6) | 1 (12) | 1 (12) |
| No. of CO based Questions with Max.marks | | | CO 1 | | CO 2 | CO 3 | CO 4 | CO 5 |
| | | | 6 (6) | | 1 (6) | 1 (6) | 1 (12) | 1 (12) |

- **MC**-Major Core, **AR**–Allied Regular, **AO**–Allied Optional, **MS**-Major Special, **ME**-Major Elective, **GL**-General Languages, **NME**-Non Major Elective.
- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out etc.,But, K1 and K2 should carry equal weightage.

In **Section D** students have choice between K5 and K6. III Component Assessment carries 40% of CIA and the assessment(s) should be for cognitive levels **K1 to K4** and all should carry equal weightage.

I BSc  Statistics                                                                               dd.mm.yyyy

Time : 10.00 am to 11.30 am                                                   Max. Marks : 30

| SECTION A | | |
|---|---|---|
| Answer ALL the Questions in one or two sentences             (6 x 1 = 6 Marks) | | |
| 1. | If X is uniformly distributed with mean 1 and variance 4/3, find f(x). | K1 | CO1 |
| 2. | Recall any four characteristics of the Normal distribution. | K1 | CO1 |
| 3. | Under what conditions binomial distribution can be approximated by the Normal distribution | K1 | CO1 |
| 4. | If the cumulative distribution function of a continuous random variable X is F(x), Extend the cumulative distribution function for Y=X+a. | K2 | CO1 |
| 5. | Demonstrate the mode of Chi-square distribution with n degrees of freedom. | K2 | CO1 |
| 6. | Write down the joint pdf of $i^{th}$ and jth order statistics | K2 | CO1 |
| SECTION B | | |
| Answer any ONE of the following in 150 words                (1 x 6 = 6 Marks) | | |
| 7. | The variables X & Y have the joint p.d.f given by $f(x,y) = \frac{1}{3}(x + y); 0 \le x \le 1, 0 \le y \le 2$. Make use of Karl Pearson's method to find correlation coefficient between X and Y. | K3 | CO2 |
| 8. | Identify the significance of MGF and obtain the MGF of normal distribution. | K3 | CO2 |
| SECTION C | | |
| Answer any ONE of the following in 150 words                     (1 x 6 = 6 Marks) | | |
| 9. | Examine the mean and Variance of Beta distribution of first kind. | K4 | CO3 |
| 10. | Distinguish between t-distribution and chi-square distribution | K4 | CO3 |
| SECTION D | | |
| Answer any ONE of the following in 100 words                (1 x 12 = 12 Marks) | | |
| 11. | If X has a uniform distribution in [0 ,1]. Evaluate the distribution of  -2logX. Also, Identify the distribution. | K5 | CO4 |
| 12. | Summarise additive property of Chi-Square distribution. | K6 | CO5 |

# CL AND CO BASED END SEMESTER EXAMINATION QUESTION PAPER FORMAT FOR UG THEORY COURSES
## (MC, AR, AO, MS, ME and GL)

| SECTION | | | Q. NO | K1 | K2 | K3 | K4 | K5 | K6 |
|---|---|---|---|---|---|---|---|---|---|
| A | (4 x 5 = 20) Answer ALL | | 1 | + | | | | | |
| | | | 2 | + | | | | | |
| | | | 3 | | + | | | | |
| | | | 4 | | + | | | | |
| B | (2 x 10 = 20) Answer 2 out of 4 | | 5 | | | + | | | |
| | | | 6 | | | + | | | |
| | | | 7 | | | + | | | |
| | | | 8 | | | + | | | |
| C | (2 x 10 = 20) Answer 2 out of 4 | | 9 | | | | + | | |
| | | | 10 | | | | + | | |
| | | | 11 | | | | + | | |
| | | | 12 | | | | + | | |
| D | (2 x 20 = 40) Answer 2 out of 4 | | 13 | | | | | + | |
| | | | 14 | | | | | + | |
| | | | 15 | | | | | | + |
| | | | 16 | | | | | | + |
| No. of CL based Questions with Max. marks | | | | 2 (10) | 2 (10) | 2 (20) | 2 (20) | 2 (40) | 2 (40) |
| No. of CO based Questions with Max. marks | | | | CO 1 | | CO 2 | CO 3 | CO 4 | CO 5 |
| | | | | 4 (20) | | 2 (20) | 2 (20) | 2 (40) | 2 (40) |

- **MC**-Major Core, **AR**–Allied Regular, **AO**–Allied Optional, **MS**-Major Special, **ME**-Major Elective, **GL**-General Languages.
- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out, but K1 andK2 should carry equal weightage.

In **Section D** students have choice between K5 and K6.

**LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034**

**Department of Statistics**

**END SEMESTER EXAMINATION, OCTOBER, 2021**

**UST 2501 Continuous Distributions (MC)**

I BSc                                                                                                     15.11.2021

Duration : 3 hrs                                                                                   Max. Marks : 100

| SECTION A |  |  |  |
|---|---|---|---|
| **Answer ALL the Questions** |  |  |  |
| **1.** | **Define the following**                              **(5 x 1 = 5 Marks)** |  |  |
| a) | Stochastic independence. | K1 | CO1 |
| b) | Marginal distribution of X and Y from their joint distribution function | K1 | CO1 |
| c) | Standard Normal Variate and write it's p.d.f | K1 | CO1 |
| d) | Beta distribution of II kind | K1 | CO1 |
| e) | Probability Convergence | K1 | CO1 |
| **2.** | **Fill in the blanks**                                   **(5 x 1 = 5 Marks)** |  |  |
| a) | The normal distribution is a limiting case of binomial distribution if _____ | K1 | CO1 |
| b) | The relationship between beta distributions of I and II kind is _____ | K1 | CO1 |
| c) | The characteristics function of Gamma distribution is _____ | K1 | CO1 |
| d) | The t- distribution with n = 1 is sometimes referred to as the _____ | K1 | CO1 |
| e) | The standard deviation of the chi-square distribution is twice the _____ | K1 | CO1 |
| **3.** | **Match the following**                                **(5 x 1 = 5 Marks)** |  |  |
| a) | Uniform             - 1) $f(x) = \frac{1}{\lambda((x-\mu)^2 + \lambda^2)}$ , $-\infty < x < \infty, \lambda > 0$ | K2 | CO1 |
| b) | Normal             - 2) $f(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}$, $-\infty < x < \infty$, | K2 | CO1 |
| c) | Exponential         - 3) $f(x) = \frac{1}{b-a}$, $a \le x \le b$ | K2 | CO1 |

| | | | | |
|---|---|---|---|---|
| d) | Beta | - 4) $f(x) = \frac{1}{\beta(m,n)} x^{m-1}(1-x)^{n-1}, 0 \leq x \leq 1$ | K2 | CO1 |
| e) | Cauchy | - 5) $f(x) = \frac{1}{a} e^{-x/a}, x \geq 0$ | K2 | CO1 |

| 4. | **TRUE or FALSE** | **(5 x 1 = 5 Marks)** | | |
|---|---|---|---|---|
| a) | The joint distribution function of (X,Y) is a nondecreasing function in each of the variables X and Y. | | K2 | CO1 |
| b) | Every unique pair of mean (μ) and standard deviation (σ) describes a different normal distribution. | | K2 | CO1 |
| c) | The exponential distribution is always skewed right. | | K2 | CO1 |
| d) | A continuous uniform distribution U(0, 800) will have μ = 400 and σ = 230.94. | | K2 | CO1 |
| e) | The t-distribution approaches the normal distribution as the number of degrees of freedom decreases. | | K2 | CO1 |

## SECTION B

**Answer any TWO of the following in 150 words**          **(2 x 10 = 20 Marks)**

| 5. | Let (X,Y) be a two dimensional continuous random variable with p.d.f  f(x,y) = 8xy, 0<y<x<1, attain E(Y/X). | K3 | CO2 |
|---|---|---|---|
| 6. | Explain and prove linearity property of a normal distribution. | K3 | CO2 |
| 7. | Given a normal curve with mean = 25.3 and standard deviation = 8.1, determine the area under the curve between 20.6 and 29.1. | K3 | CO2 |
| 8. | Produce  mean and variance of exponential distribution | K3 | CO2 |

## SECTION C

**Answer any TWO of the following in 150 words**          **(2 x 10 = 20 Marks)**

| 9. | If X has a Cauchy distribution, then detect p.d.f. for $X^2$ and investigate the distribution. | K4 | CO3 |
|---|---|---|---|
| 10. | Let $(X_1, X_2, ....X_n)$ be an n-dimensional random variable, then Ensure that X(k) the order statistic of order k, $1 \leq k \leq n$ is also a random variable. | K4 | CO3 |

| 11. | Subway trains on a certain line run every half hour an between mid – night and six in the morning. Figure out the probability that a man entering the station at a random time during this period will have to wait at least twenty minutes. | K4 | CO3 |
|---|---|---|---|
| 12. | Identify mean and variance of gamma distribution. | K4 | CO3 |

## SECTION D

**Answer any TWO of the following in 250 words**                    **(2 x 20 = 40 Marks)**

| 13. | Given $f(xy) = \begin{cases} x\,e^{-x(1+y)}, & x \geq 0, y \geq 0 \\ 0, & otherwise \end{cases}$ <br><br> Estimate  (i) E(XY)     (ii) E(YX) and Verify that E(Y) does not exist. | K5 | CO4 |
|---|---|---|---|
| 14. | Explain and Test that odd order moments vanished, but even order moments exist in the case of normal distribution. | K5 | CO4 |
| 15. | Evaluate the relationship between Chi-square, t and F distributions. | K6 | CO5 |
| 16. | Summarise and support the arguments by giving the proof of Lindberg –Levy central limit theorem. | K6 | CO5 |

## UNIT WISE DISTRIBUTION OF CL AND CO BASED QUESTIONS AND MARKS FOR
## END OF SEMESTER QUESTION PAPER SETTING FOR UG COURSES
## (MC, AR, AO, MS, ME and GL)

| | SECTION A | | SECTION B | SECTION C | SECTION D | |
|---|---|---|---|---|---|---|
| | K1 | K2 | K3 | K4 | K5 | K6 |
| UNIT I | 2 (1) | 2 (1) | - | 1 (10) | - | |
| UNIT II | 2 (1) | 2 (1) | 1 (10) | 1 (10) | 1 (20) | - |
| UNIT III | 2 (1) | 2 (1) | 1 (10) | 1 (10) | 1 (20) | - |
| UNIT IV | 2 (1) | 2 (1) | 1 (10) | 1 (10) | - | 1 (20) |
| UNIT V | 2 (1) | 2 (1) | 1 (10) | - | - | 1 (20) |
| No. of CL based Questions with Max. Marks | 10 (10) | 10 (10) | 2 (20) | 2 (20) | 2 (40) | 2 (40) |
| No. of CO based Questions with Max. Marks | CO1 | | CO2 | CO3 | CO4 | CO5 |
| | 20 (20) | | 2 (20) | 2 (20) | 2 (40) | 2 (40) |

**MC**-Major Core, **AR**–Allied Regular, **AO**–Allied Optional, **MS**-Major Special, **ME**-Major Elective, **GL**-General Languages.

In **Section D** students have choice between K5 and K6.

## CL AND CO BASED MARKS DISTRIBUTION FOR DIRECT ASSESSMENTS OF UG COURSES
## MC, AR, AO, MS, ME and GL

| SECTION | CL | CO | CIA I | CIA II | III Component | Semester | Total (200) | CL and CO % |
|---|---|---|---|---|---|---|---|---|
| A | K1, K2 | CO1 | 6 | 6 | 20 | 20 | 52 | 26% |
| B | K3 | CO2 | 6 | 6 | 10 | 20 | 42 | 21% |
| C | K4 | CO3 | 6 | 6 | 10 | 20 | 42 | 21% |
| D | K5, K6 | CO4, CO5 | 12 | 12 | - | 40 | 64 | 32% |

**MC**-Major Core, **AR**–Allied Regular, **AO**–Allied Optional, **MS**-Major Special, **ME**-Major Elective, **GL**-General Languages.

# CL AND CO BASED CIA AND SEMESTER QUESTION PAPER FORMAT FOR

# UG LAB COURSES* (MC, AR, AO, ME)

| SECTION | MARKS | Q. NO | K1 | K2 | K3 | K4 | K5 | K6 |
|---------|-------|-------|----|----|----|----|----|----|
| A | 20 | 1 | + | | | | | |
| | | 2 | | + | | | | |
| B | 20 | 3 | | | + | | | |
| C | 20 | 4 | | | | + | | |
| D | 20 | 5 | | | | | + | |
| E | 20 | 6 | | | | | | + |
| No. of CL based Questions with Max. marks | | | 1(10) | 1(10) | 1(20) | 1(20) | 1(20) | 1(20) |
| No. of CO based Questions with Max. marks | | | CO 1 | | CO 2 | CO 3 | CO 4 | CO 5 |
| | | | 2(20) | | 1(20) | 1(20) | 1(20) | 1(20) |

**No Comp III for Lab Courses and total marks assigned to CIA is 50**

III BSc                                                                                                    dd/mm/yyyy

Duration : 3 hrs                                                                                 Max. Marks : 100

## SECTION A

**(20 Marks)**

1   Consider the following data and create data frame with the name **student**                    K1    CO1

<table>
<tr><th colspan="8">Table 1</th></tr>
<tr><th>Stu_id</th><th>Marks</th><th>No_hrs_<br>Study</th><th>No_hrs_<br>play</th><th>No_Hrs_<br>Watching_<br>Movies</th><th>No_hrs_<br>travel</th><th>No_hrs_<br>sleeping</th><th>gender</th></tr>
<tr><td>101</td><td>60</td><td>5</td><td>3</td><td>5</td><td>5</td><td>6</td><td>F</td></tr>
<tr><td>102</td><td>43</td><td>3</td><td>4</td><td>6</td><td>4</td><td>7</td><td>M</td></tr>
<tr><td>103</td><td>63</td><td>7</td><td>5</td><td>2</td><td>2</td><td>8</td><td>F</td></tr>
<tr><td>104</td><td>62</td><td>8</td><td>6</td><td>1</td><td>1</td><td>8</td><td>M</td></tr>
<tr><td>105</td><td>99</td><td>11</td><td>2</td><td>3</td><td>2</td><td>6</td><td>F</td></tr>
<tr><td>106</td><td>66</td><td>7</td><td>6</td><td>2</td><td>1</td><td>8</td><td>F</td></tr>
<tr><td>107</td><td>67</td><td>6</td><td>5</td><td>2</td><td>4</td><td>7</td><td>F</td></tr>
<tr><td>108</td><td>90</td><td>8</td><td>4</td><td>4</td><td>1</td><td>7</td><td>M</td></tr>
<tr><td>109</td><td>40</td><td>3</td><td>5</td><td>7</td><td>3</td><td>6</td><td>M</td></tr>
<tr><td>110</td><td>82</td><td>8</td><td>4</td><td>3</td><td>2</td><td>7</td><td>M</td></tr>
<tr><td>111</td><td>69</td><td>7</td><td>7</td><td>1</td><td>1</td><td>8</td><td>F</td></tr>
<tr><td>112</td><td>49</td><td>3</td><td>6</td><td>6</td><td>2</td><td>7</td><td>F</td></tr>
<tr><td>113</td><td>54</td><td>4</td><td>4</td><td>5</td><td>5</td><td>6</td><td>M</td></tr>
<tr><td>114</td><td>92</td><td>9</td><td>3</td><td>4</td><td>2</td><td>6</td><td>M</td></tr>
<tr><td>115</td><td>83</td><td>6</td><td>5</td><td>3</td><td>4</td><td>6</td><td>F</td></tr>
<tr><td>116</td><td>62</td><td>5</td><td>6</td><td>3</td><td>3</td><td>7</td><td>F</td></tr>
<tr><td>117</td><td>81</td><td>7</td><td>7</td><td>2</td><td>2</td><td>6</td><td>M</td></tr>
<tr><td>118</td><td>68</td><td>11</td><td>1</td><td>2</td><td>2</td><td>8</td><td>M</td></tr>
<tr><td>119</td><td>49</td><td>6</td><td>5</td><td>4</td><td>4</td><td>5</td><td>M</td></tr>
<tr><td>120</td><td>87</td><td>7</td><td>4</td><td>5</td><td>2</td><td>6</td><td>M</td></tr>
</table>

2   a)  Find  summary Statistics for all the variables in Table 1                                    K1    CO1

b)  Create a new variable total number of hours spent for each student in different objects

    for the above table 1

## SECTION B

**(20 Marks)**

**3.** a) Sort the data in ascending and descending order based on marks.        K3   CO2

    b) Sub set the observations with marks from 40 to 60.

    c) Create the indicator variable Male =1 and Female = 0.

    d) Find Pearson correlation between Marks and No_hrs_study.

## SECTION C

**(20 Marks)**

**4.** Measurement of the fat content of two brands of ice cream, Brand A and Brand B yielded   K4   CO3
from ten ice cream types are given below:

| Brand A | 13.5 | 14 | 13.6 | 12.9 | 13.0 | 12.4 | 13.8 | 13.5 | 12.7 | 12.9 |
|---------|------|----|------|------|------|------|------|------|------|------|
| Brand B | 12.9 | 13 | 12.4 | 13.5 | 12.7 | 12.8 | 12.9 | 12.3 | 13.4 | 12.6 |

    Do the brands differ with respect to fat content?

## SECTION D

**(20 Marks)**

**5.** A project manager is interested to test the difference between process completion time under   K5   CO4
three different methods. The data is given below

| Method A | 9.3 | 9.4 | 9.6 | 10 | 12.4 | 13 | 10.4 | 11.1 | 12.2 | 13.5 |
|----------|-----|-----|-----|----|------|----|------|------|------|------|
| Method B | 12.2 | 11.4 | 13.2 | 14.4 | 15.4 | 13.4 | 14.4 | 10.5 | 10.8 | 12.4 |
| Method C | 10.2 | 8.7 | 9.7 | 12.1 | 11.4 | 12.4 | 11.8 | 13.4 | 14.5 | 15.4 |

Perform one way Analysis of Variance

## SECTION E

**(20 Marks)**

**6.** Consider the data on Number of Defectives in Samples of 100 ceramic substrates    K6   CO5

| sample | No of defectives | Size |
|--------|------------------|------|
| 1 | 33 | 100 |
| 2 | 37 | 100 |
| 3 | 21 | 100 |
| 4 | 39 | 100 |
| 5 | 18 | 100 |
| 6 | 20 | 100 |
| 7 | 35 | 100 |
| 8 | 41 | 100 |
| 9 | 33 | 100 |
| 10 | 37 | 100 |

Construct control chart for fraction defectives and control chart for number of defectives

based on the data given and interpret on process control.

# COMPONENT III ASSESSMENTS AND RUBRICS

**Mini Project**

The project work is included as part of the curriculum to impart research skills. It is optional for UG and mandatory for PG students. Students can select any staff from the department as their research guide. They are encouraged to select research problems relevant to society and environment. The project report of UG and Dissertation of PG students will be evaluated by external examiners and the students will present their work in viva voce.

**Rubrics for evaluation**

| S. No | Criteria | Max. Marks |
|-------|----------|------------|
| 1. | Review of Literature | 10 |
| 2. | Hypothesis Design | 10 |
| 3. | Materials and Methodology | 5 |
| 4. | Experimental Design | 10 |
| 5. | Validation of scientific Data | 10 |
| 6. | Discussion and Recommendation | 10 |
| 7. | Report/Dissertation | 20 |
| 8. | Presentation | 10 |
| 9. | Relevance of the study | 15 |

**Seminar/Assignment**

Seminars are optional to UG and mandatory to PG. Topics for the seminar are suggested by the course teacher and the students are encouraged to collective exhaustive information on the chosen topic, arrange them in order and make a presentation. They are expected to use visual aids, models, tools for the presentation and circulate relevant literature to the students.

**Rubrics for evaluation**

| S. No | Criteria | Max. Marks |
|-------|----------|------------|
| 1. | Topic introduction | 10 |
| 2. | Collection of literature (primary, secondary and tertiary) | 10 |
| 3. | Presentation methodology | 20 |
| 4. | Articulation and Communication skills | 10 |
| 5. | Time management | 10 |
| 6. | Discussion and Interaction | 20 |
| 7. | Summary and Conclusion | 20 |

**Internship/Field visit**

Internship allows the students to gain hands on experience and industry exposure. The internship for UG is conducted during the Christmas Vacation for minimum of 15 days. The UG students will be sent to industries/organization the department signed MoU with. The PG students are free to select industry/organization of their choice and minimum period of internship is 15 days.

**Rubrics for evaluation of Internship**

| S. No | Criteria | Max. Marks |
|-------|----------|------------|
| 1. | Industry/Organization profile | 10 |
| 2. | Thrust areas and specialization | 10 |
| 3. | Internship module and participation | 20 |
| 4. | Expertise of the industry/organization | 10 |
| 5. | Regularity and hands on training | 10 |
| 6. | Presentation/Demonstration | 20 |
| 7. | Report writing | 20 |

Signature

Dr. S. Selva Arul Pandian
LOCF Coordinator

Signature

Dr. Martin Luther William
HOD / Statistics