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**ANNAMALAI UNIVERSITY**

**Affiliated Colleges**

**202. B.Sc. STATISTICS**

**Programme Structure and Scheme of Examination (under CBCS)**

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Part | Course Code | Study Components & Course Title | Credit | Hours/Week | Maximum Marks |
| CIA | ESE | Total |
|  |  | SEMESTER – I |  |  |  |  |  |
| I | 23UTAML11/23UHINL11/23UFREL11 | Language – I:பொது தமிழ்– I: தமிழிலக்கிய வரலாறு-1/Hindi-I/French-I | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL12 | General English – I | 3 | 6 | 25 | 75 | 100 |
| III | 23USTAC13 | Core – I: Descriptive Statistics | 5 | 5 | 25 | 75 | 100 |
| 23USTAC14 | Core –II : Probability Theory | 5 | 5 | 25 | 75 | 100 |
| 23UMASE15 | Elective – I:Mathematics for Statistics | 3 | 4 | 25 | 75 | 100 |
| IV | 23UTAMB1623UTAMA16 | Skill Enhancement Course-1\*NME-I/Basic Tamil – I /Advanced Tamil - I | 2 | 2 | 25 | 75 | 100 |
| 23USTAF17 | Foundation Course:Quantitative Aptitude | 2 | 2 | 25 | 75 | 100 |
|  |  | Total | 23 | 30 |  |  | 700 |
|  |  | SEMESTER – II |  |  |  |  |  |
| I | 23UTAML21/23UHINL21/23UFREL21 | Language – II:பொது தமிழ் -II: தமிழிலக்கிய வரலாறு-2/Hindi-II/French-II | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL22 | General English –II: | 3 | 6 | 25 | 75 | 100 |
| III | 23USTAC23 | Core –III: Matrix and Linear Algebra | 5 | 5 | 25 | 75 | 100 |
| 23USTAC24 | Core –IV Distribution theory | 5 | 5 | 25 | 75 | 100 |
| 23UNUME25 | Elective – II:Numerical Methods - I  | 3 | 4 | 25 | 75 | 100 |
| IV | 23UTAMB2623UTAMA26 | Skill Enhancement Course –2\*NME-II/Basic Tamil – II /Advanced Tamil - II | 2 | 2 | 25 | 75 | 100 |
| 23USECG27 | Skill Enhancement Course –3Internet and its Applications (Common Paper) | 2 | 2 | 25 | 75 | 100 |
| 23UNMSD01 | Language Proficiency for employability: Overview of English Communication\*\* | 2 | - |  |  | 100 |
|  |  | Total | 25 | 30 |  |  | 800 |

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|  |  | SEMESTER – III |  |  |  |  |  |
| I | 23UTAML31/23UHINL31/23UFREL31 | Language – III:பொது தமிழ் -III: தமிழக வரலாறும், பண்பாடும்/Hindi-III/French-III | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL32 | General English – III | 3 | 6 | 25 | 75 | 100 |
| III | 23USTAC33 | Core – V: Estimation theory | 5 | 5 | 25 | 75 | 100 |
| 23USTAC34 | Core –VI: Sampling techniques  | 5 | 5 | 25 | 75 | 100 |
| 23USTAE35 | Elective – III:Real Analysis  | 3 | 4 | 25 | 75 | 100 |
| IV | 23USTAS36 | Skill Enhancement Course – 4:Data Base Management System | 1 | 1 | 25 | 75 | 100 |
| 23USTAS37 | Skill Enhancement Course – 5:Statistical Data Analysis - I (Software Based Practical) | 2 | 2 | 25 | 75 | 100 |
|  |  | Environmental Studies |  | 1 |  |  |  |
|  |  | Total | 22 | 30 |  |  | 700 |

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|  |  | SEMESTER – IV |  |  |  |  |  |
| I | 23UTAML41/23UHINL41/23UFREL41 | Language – IV:பொது தமிழ் -IV: தமிழும் அறிவியலும்/Hindi-IV/French-IV | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL42 | General English –IV | 3 | 6 | 25 | 75 | 100 |
| III | 23USTAC43 | Core – VII: Testing of Statistical Hypothesis | 5 | 5 | 25 | 75 | 100 |
| 23USTAC44 | Core –VIII: Statistical Quality Control | 5 | 5 | 25 | 75 | 100 |
| 23USTAE45 | Elective – IV:Official Statistics | 3 | 3 | 25 | 75 | 100 |
| IV | 23USTAS46 | Skill Enhancement Course – 6:Statistical Data Analysis using R programming | 2 | 2 | 25 | 75 | 100 |
| 23USTAS47 | Skill Enhancement Course – 7:Statistics Practical (Software Based) | 2 | 2 | 25 | 75 | 100 |
| 23UEVSG48 | Environmental Studies | 2 | 1 | 25 | 75 | 100 |
|  |  | Total | 25 | 30 |  |  | 800 |

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|  |  | SEMESTER – V |  |  |  |  |  |
| III | 23USTAC51 | Core-IX: Stochastic Processes | 4 |  5 | 25 | 75 | 100 |
| 23USTAC52 | Core-X: Regression Analysis | 4 | 5 | 25 | 75 | 100 |
| 23USTAP53 | Core – XI: Practical covering Core - VIII, IX and X | 4 | 5 | 25 | 75 | 100 |
| 23USTAD54 | Core –XII-Project with Viva-voce  | 4 | 5 | 25 | 75 | 100 |
| 23USTAE55 | Elective – V:Operations Research | 3 | 4 | 25 | 75 | 100 |
| 23USTAE56 | Elective – VI:Econometrics | 3 | 4 | 25 | 75 | 100 |
| IV | 23UVALG57 | Value Education | 2 | 2 | 25 | 75 | 100 |
| 23USTAI58 | Summer Internship **++** | 2 | - | - | - | 100 |
|  |  | Total | 26 | 30 |  |  | 800 |

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| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | SEMESTER – VI |  |  |  |  |  |
|  | 23USTAC61 | Core-XIII: Design of Experiments | 4 | 6 | 25 | 75 | 100 |
| III | 23USTAC62 | Core-XIV: Demography | 4 | 6 | 25 | 75 | 100 |
| 23USTAP63 | Core-XV: Practical covering Core-XIII and XIV | 4 | 6 | 25 | 75 | 100 |
| 23USTAE64 | Elective-VII: Actuarial Statistics | 3 | 5 | 25 | 75 | 100 |
| 23USTAE65 | Elective-VIII: Time Series and Index Numbers | 3 | 5 | 25 | 75 | 100 |
| IV | 23USTAF66 | Professional Competency Skills:Python Programming | 2 | 2 | 25 | 75 | 100 |
| V | 23USTAX67 | Extension Activity | 1 | - | 100 | - | 100 |
|  |  | Total | 21 | 30 |  |  | 700 |
|  |  | Grand Total | 142 |  |  |  | 4500 |

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| --- | --- | --- | --- | --- |
|  | List of Non – Major Elective offered to other Department |  |  |  |
| I | 23USTAN16 | Statistical Methods I | 2 | 2 | 25 | 75 | 100 |
| II | 23USTAN26 | Statistical Methods II | 2 | 2 | 25 | 75 | 100 |

\* PART-IV: NME / Basic Tamil / Advanced Tamil (Any one)

Students who have not studied Tamil upto12th Standard and have taken any Language other than Tamil in Part-I, must choose Basic Tamil-I in First Semester & Basic Tamil-II in Second Semester.

Students who have studied Tamil upto10th& 12th Standard and have taken any Language other than Tamil in Part-I, must choose Advanced Tamil-I in First Semester and Advanced Tamil-II in Second Semester.

\*\* The course “23UNMSD01: Overview of English Communication” is to be taught by the experts from
 Naan Mudhalvan Scheme team. However, the faculty members of Department of English should
 coordinate with the Naan Mudhalvan Scheme team for smooth conduct of this course.

++Students should complete two weeks of internship before the commencement of V semester.

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System**

**for all UG courses including Lab Hours**

**First Year – Semester-I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language – Tamil  | 3 | 6 |
| Part II | English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses  | 13 | 14 |
| Part IV | Skill Enhancement Course SEC-1 (NME-I) | 2 | 2 |
| Foundation Course | 2 | 2 |
|  |  | **23** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language – Tamil | 3 | 6 |
| Part II |  English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses  | 13 | 14 |
| Part IV | Skill Enhancement Course -SEC-2 (NME-II) | 2 | 2 |
| Skill Enhancement Course -SEC-3 (Discipline / Subject Specific) | 2 | 2 |
|  |  | **23** | **30** |

**Second Year – Semester-III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language - Tamil | 3 | 6 |
| Part II |  English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses | 13 | 14 |
| Part IV | Skill Enhancement Course -SEC-4 (Entrepreneurial Based) | 1 | 1 |
| Skill Enhancement Course -SEC-5 (Discipline / Subject Specific) | 2 | 2 |
|  E.V.S  | - | 1 |
|  |  | **22** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part I | Language - Tamil | 3 | 6 |
| Part II |  English | 3 | 6 |
| Part III | Core Theory, Practical & Elective Courses | 13 | 13 |
| Part IV | Skill Enhancement Course -SEC-6 (Discipline / Subject Specific) | 2 | 2 |
| Skill Enhancement Course -SEC-7 (Discipline / Subject Specific) | 2 | 2 |
|  E.V.S  | 2 | 1 |
|  |  | **25** | **30** |

**Third Year**

**Semester-V**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part III | Core Theory, Practical, Project & Elective Courses | 22 | 28 |
| Part IV | Value Education  | 2 | 2 |
| Internship / Industrial Visit / Field Visit | 2 | - |
|  |  | **26** | **30** |

**Semester-VI**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part III | Core Theory, Practical & Elective Courses | 18 | 28 |
| Part IV | Professional Competency Skill | 2 | 2 |
| Part V | Extension Activity | 1 | - |
|  |  | **21** | **30** |

**Consolidated Semester wise and Component wise Credit distribution**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parts**  | **Sem I** | **Sem II** | **Sem III** | **Sem IV** | **Sem V** | **Sem VI** | **Total Credits** |
| **Part I** | 3 | 3 | 3 | 3 | - | - | 12 |
| **Part II** | 3 | 3 | 3 | 3 | - | - | 12 |
| **Part III** | 13 | 13 | 13 | 13 | 22 | 18 | 92 |
| **Part IV**  | 4 | 4 | 3 | 6 | 4 | 2 | 23 |
| **Part V** | - | - | - | - | - | 1 | 1 |
| **Total** | 23 | 23 | 22 | 25 | 26 | 21 | **140** |

**\*Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components Part IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

**CREDIT DISTRIBUTION FOR U.G. PROGRAMME**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Part** | **Course Details** | **No. of Courses** | **Credit per course** | **Total****Credits** |
| **Part I** | Tamil | 4 | 3 | 12 |
| **Part II** | English | 4 | 3 | 12 |
| **Part III** | Core Courses  | 15 | 4/5 | 68 |
| Elective Courses: Generic / Discipline Specific (3 or 2+1 Credits) | 8 | 3 | 24 |
| **Part I, II and III Credits**  | 116 |
| **Part IV** | Skill Enhancement Courses / NME / Language Courses | 7 | 1/2 | 15 |
| Professional Competency Skill Course | 1 | 2 | 2 |
| Environmental Science (EVS) | 1 | 2 | 2 |
| Value Education  | 1 | 2 | 2 |
| Internship | 1 | 2 | 2 |
| **Part IV Credits** | **23** |
| **Part V** | Extension Activity (NSS / NCC / Physical Education) | 1 | 1 | 1 |
| **Total Credits for the UG Programme**  | **140** |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze(K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate(K5)** | Longer essay/Evaluation essay, Critique or justify with pros and cons |
| **Create(K6)** | Check knowledge in specific or off beat situations, Discussion, Debating or Presentations |

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| **Programme Outcomes:** | **PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study**PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one’s views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.**PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one’s learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.**PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation**PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team**PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.**PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.**PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one’s life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demon starting the ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.**PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.**PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling. |
| **Programme Specific Outcomes:** | **PSO1**: To enable students to apply basic microeconomic, macroeconomic and monetary concepts and theories in real life and decision making.**PSO 2**: To sensitize students to various economic issues related to Development, Growth, International Economics, Sustainable Development and Environment.**PSO 3**: To familiarize students to the concepts and theories related to Finance, Investments and Modern Marketing.**PSO 4**: Evaluate various social and economic problems in the society and develop answer to the problems as global citizens.**PSO 5:** Enhance skills of analytical and critical thinking to analyze effectiveness of economic policies. |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PO 1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** |
| **PSO 1** | Y | Y | Y | Y | Y | Y | Y | Y |
| **PSO 2** | Y | Y | Y | Y | Y | Y | Y | Y |
| **PSO3** | Y | Y | Y | Y | Y | Y | Y | Y |
| **PSO 4** | Y | Y | Y | Y | Y | Y | Y | Y |
| **PSO 5** | Y | Y | Y | Y | Y | Y | Y | Y |

 **3 – Strong, 2- Medium, 1- Low**

|  |  |  |
| --- | --- | --- |
| **SEMESTER: I****PART: III****CORE COURSE – I** | **23USTAC13: DESCRIPTIVE STATISTICS** | **Credit:5****Hours:5** |

The main objectives of the course are:

1. It explains the important concepts of statistics and statistical data.
2. It provides to formulate the visualization of frequency distribution.
3. Also they measure the averages, dispersions, lack of symmetry, moments, relationship among variables. Estimate and predict the unknown and future values.
4. Study of non-linear and consistency of the data.

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| **Unit-I:**  Statistics: Introduction - Definition – Functions - Applications - Limitations. Organising a Statistical Survey: Planning the survey - Executing the survey-Collection of Data: Primary and secondary data - Methods of collecting primary data - Sources of secondary data. Sampling: Census and Sample methods. Classification-Types - Formation of frequency distribution-Tabulation - parts of a Table - Types. Diagrammatic representation – Types. Graphical representation - Graphs of frequency distributions. Merits and Limitations of diagrams and graphs. |
| **Unit-II:** Measures of Central tendency: Introduction-Definitions-Types - Mean-Median-Mode-Geometric mean-Harmonic Mean-Weighted mean - Merits and Demerits-Measures of Dispersion: Introduction – Definition – Types – Range - Quartile deviation - Mean deviation - Standard deviation - Co-efficient of variation – Lorenz curve - Merits and Demerits.**Unit-III:** Skewness: Introduction-Definition-Types-Karl Pearson’s – Bowley’s - Kelly’s methods – Their merits and demerits. Kurtosis: Introduction-Definition-Types-Its merits and demerits. Moments: Introduction - Definition-Types - Raw, Central moments and their relations |
| **Unit-IV**: Correlation analysis: Introduction - Definition - Types – Ungrouped and Grouped data – Probable error – properties - Rank correlation – Partial and Multiple correlations - Regression analysis: Introduction - Definition – Regression Equations -Multiple regression - Principle of least squares for first degree, Second degree, Exponential and Power curves |
| **Unit-V** : Theory of Attributes: Introduction – Definition-Classes and Class frequencies-Consistency of data-Independence of attributes-Association of attributes-Yule’s coefficient and -Coefficient of Colligation. |

**Recommended Text**

1. Gupta S.C. and Kapoor V.K (2015): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

**Reference Books**

1. Rohatgi, V.K. (1984): An introduction to probability theory and mathematical statistics.
2. Hogg. R.V. and Craig. A.T. (1978) : Introduction to Mathematical Statistics, McGraw Hill Publishing Co. Inc. New York.
3. Mood A.M. Graybill, F.A. and Bose. D.C. (1974): Introduction to the theory of Statistics, McGraw Hill Publishing Co. Inc. New York.
4. Sanjay Arora and Bansilal (1989): New Mathematical Statistics, Satyaprakashan, New Delhi

**Website and e-Learning Source:**

e-books, tutorials on MOOC/SWAYAM courses on the subject

[www.khanacademy.org/math/statistics-probability/random-variables-stats-library](http://www.khanacademy.org/math/statistics-probability/random-variables-stats-library)

<https://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2014/>

# **Course Learning Outcomes**

Students will be able to

**CLO-1:** Describe the scope, functions, applications and limitations of Statistics.

**CLO-2:** Also to explain the statistical survey, collection of data, sampling and presentation of data.

**CLO-3:** Discuss the importance and uses of central values and dispersions for the various types of data.

**CLO-4:** Also to measure the various measures of averages and scatteredness of the mass of data in a series.

**CLO-5:** Explain about the lack of symmetry, rth moments and peakedness of the frequency distributions.

**CLO-6:** Ability to apply in data

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| **SEMESTER: I****PART: III****CORE COURSE – II** | **23USTAC14: PROBABILITY THEORY** | **Credit:5****Hours:5** |

**Objectives of the Course**

The main objectives of this course are:

1. To describe the importance and scope of probability theory and to predict the chance of an experimental outcomes.
2. It provides the study of random variable, distribution function, mathematical expectation,
3. Generating function and law of large numbers.
4. Two-dimentional variables and its distributions

**Unit-I:** Theory of Probability: Introduction-Basic terminology- Definition - Axiomatic approach – Types of Events - Conditional Probability - Addition and Multiplication theorems of Probability for ‘two’ and ‘n’ events (Statement and Proof) - Boole’s inequality (Statement and Proof)- Bayes’ theorem of Probability (Statement and Proof with numerical illustration -very simple problems)

**Unit-II:** Random variables and Distribution functions: Introduction - Discrete random variable: Probability mass function- Discrete distribution function, Properties. Continuous random variable : Probability density function and properties, measures of central tendency, dispersion, Skewness and kurtosis for continuous Probability distribution.

**Unit-III:** Two dimensional random variables - Joint probability mass function- Marginal probability function, Conditional probability function. Two dimensional distribution functions-Marginal distribution functions - Joint density function-Marginal density function - Conditional distribution function - Conditional probability density function. Transformation of One - Dimensional and Two Dimensional random variable (concept only).

**Unit-IV:** Mathematical Expectations: Introduction- Expected value of a random variable (Discrete and Continuous)-Expected value of function of a random variable - Properties of Expectation-Properties of variance- Covariance. Inequalities involving expectation: Cauchy Schwartz and Markov inequalities.

**Unit-V :** Generating functions: M.G.F-Properties-Uniqueness theorem - C.G.F-Properties- P.G.F-Properties. Characteristic Function: Properties–Inversion theorems (Statement only)- Uniqueness theorem (Statement only). Chebychev’s Inequality (Statement and Proof). Law of Large Numbers (L.L.N): Convergence in probability - Properties: Weak L.L.N - properties-Bernoulli’s L.L.N (Statement and Proof) - Khinchin’s theorems (Statement only).

**Recommended Text**

1. Gupta S.C. and Kapoor V.K (2015): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

**Reference Books**

1. Rohatgi, V.K. (1984): An introduction to probability theory and mathematical statistics.
2. Hogg. R.V. and Craig. A.T. (1978) : Introduction to Mathematical Statistics, McGraw Hill Publishing Co. Inc. New York.
3. Mood A.M. Graybill, F.A. and Bose. D.C. (1974): Introduction to the theory of Statistics, McGraw Hill Publishing Co. Inc. New York.
4. Sanjay Arora and Bansilal (1989): New Mathematical Statistics, Satyaprakashan, New Delhi

**Website and e-Learning Source**

e-books, tutorials on MOOC/SWAYAM courses on the subject

[www.khanacademy.org/math/statistics-probability/random-variables-stats-library](http://www.khanacademy.org/math/statistics-probability/random-variables-stats-library)

<https://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2014/>

# **Course Learning Outcome(for Mapping with Pos and PSOs)**

Students will be able to

**CLO-1:** Understand concepts of probability and Identify the different approaches of probability theory

**CLO-2:** Define the random variable and its respective probability values and to compare a discrete and continuous random variable.

**CLO-3:** Calculate the expected value of a random variable variance, covariance, moments and find the conditional expectation and variance of bi-variate random variable.

**CLO-4:** Estimate the measures of central values, Dispersions, Skewness and Kurtosis through the generating function

**CLO-4:** Calculate the mean and variance through some law of large numbers.

**CLO-5:** Understand bivariate random variables and its distributions

**CLO-6:** Application of probability theory in real life

|  |  |  |
| --- | --- | --- |
| **SEMESTER: I****PART: III****Elective**-**I** | **23UMASE15: Mathematics for Statistics** | **Credit:3****Hours:4** |

The main objectives of this course are:

1. The overall objective of the study is to create deep interest in learning mathematics which develop broad and balance knowledge and understanding definitions, concepts, principles and theorems.
2. It helps the students to enhance the ability of learners to apply the knowledge and skill acquired by them to solve specific theoretical and applied problems in mathematics.
3. It also encourages the students to develop a range of generic skill helpful in employment, internships in social activities.

**Unit-I** : Rational fractions: Proper and improper rational fractions. Partial fractions: Forms of partial fractions.

**Unit-II:** Series: Summation and approximations related to Binomial, Exponential and Logarithmic series -Taylor’s series, Fourier series for even and odd functions.

**Unit-III:** Theory of equations: Polynomial equations with real coefficients- imaginary and irrational roots-solving equations with related roots-equation with given numbers as roots-equation whose roots are symmetric functions of roots.

**Unit-IV:** Differential calculus: Functions – Different types – simple valued and many valued – Implicit and Explicit functions, Odd and even functions, periodic functions, algebraic and transcendental functions. Inverse functions, Limit of a function – Some standard limit (without proof) Differentiation of standard functions- standard rules of differentiation-Addition, subtraction, multiplication and quotient rules – function of function rule.

**Unit-V** : Successive differentiation: Leibnitz’s theorem, nth derivatives of standard functions – simple problems. Partial differentiation: Successive partial differentiation. Maxima and Minima for two variable functions. Homogenous function – Euler’s theorem on homogenous function.

**Recommended Text**

1. Duraipandian, P. and Udaya Baskaran, S. (2014): Allied Mathematics, Vol. – I&II,S.Chand& Company Pvt. Ltd.
2. Vittal, P.R( 2012). Allied Mathematics, Margham Publications.
3. Narayanan,SManickavachagamPillai(1993): Ancillary Mathematics, Book II : (Containing Differential Calculus) S. Viswanathan Pvt, Ltd

**Reference Books**

1. Narayanan,S and ManickavachagamPillai (1993): Ancillary Mathematics (Vol. II,Part I) : (Containing Trignometry) S. ViswanathanPvt. Ltd .
2. Narayanan, S and ManickavachagamPillai (1993): Ancillary Mathematics, Book I : (Containing Algebra). S. Viswanathan Pvt.Ltd .
3. S.J.Venkatesan (2019), Algebra,Sri Krishna Publications ,Chennai-77 , skhengg1999@gmail.com

**Website and e-Learning Source:**

e-books, tutorials on MOOC/SWAYAM courses on the subject

# **Course Learning Outcomes**

Students will be able to

**CLO-1**: Distinguish between proper and improper fractions. Express an algebraic fraction as the sum of its partial fractions.

**CLO-2**: Demonstrate the knowledge to determine the sums, expansion and approximation of series including binomial, exponential, logarithmic and fourier.

**CLO-3:** Solve problems about polynomials with real coefficients, imaginary and irrational roots. Explain the relationship between the derivative of a function as a function and the notion of the derivative.

**CLO-4:** Calculate limits of a function.

**CLO-5:** Obtain the nth derivative in successive differentiation. Apply Euler’s theorem on homogenous function

**CLO-6 :** Obtain the mathematical knowledge and skills for the better understanding of statistics as a mathematical science

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| **SEMESTER: I****PART: IV** | **[FOUNDATION COURSE]****23USTAF17: QUANTITATIVE APPTITUDE** | **Credit:2****Hours:2** |

**Course Objectives**

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|  1. This course is designed to suit the need of the outgoing students. and  |
| 2. To acquaint them with frequently asked patterns in quantitative aptitude |
| 3. To acquaint them with logical reasoning during various examinations and campus interviews. |

**Unit I:**

Ratio And Proportion, Percentages, Square root and Cube Root, Lowest Common Multiple (LCM) and Highest Common Factor (HCF).

**Unit II:** Logarithm, Permutation and Combinations, Simple Interest and Compound Interest.

**Unit III:** Time and Work, Time, Speed and Distance.

**Unit IV:** Data Interpretation, Tables, Column Graphs, Bar Graphs and Venn Diagrams.

**Unit V:** Blood Relation, Coding and Decoding, Calendars and Seating Arrangements.

**Course Outcomes**

On successful completion of the course the students will be able to:

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| 1. Understand the basic concepts of quantitative ability |
| 2. Understand the basic concepts of logical reasoning Skills |
| 3. Acquire satisfactory competency in use of reasoning |
| 4. Solve campus placements aptitude papers covering Quantitative Ability, Logical  Reasoning Ability. |
| 5. Compete in various competitive exams like CAT, CMAT, GATE, GRE, GATE, UPSC,  GPSC etc. |

**Text Books (In API Style)**

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| 1. Agarwal , R. S. *A Modern Approach To Verbal & Non Verbal Reasoning* |
| 2. Sijwali, B. S. *Analytical and Logical reasoning.* |
| 3. Agarwal , R. S. *Quantitative aptitude for Competitive examination*. |

**Supplementary Readings**

 Sijwali, B. S. *Analytical and Logical reasoning for CAT and other management entrance tes*

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| **SEMESTER: II****PART: III****(CORE COURSE –III)** | **23USTAC23: Matrix and Linear Algebra** | **Credit:5****Hours :5** |

The main objectives of this course are:

* 1. To study the basic operations of transpose and inverse of matrices
	2. To know the structure of orthogonal and unitary matrices
1. To learn the invariance properties of ranks
2. To know and to apply the concepts of vector space and matrix polynomials.

**Unit I :** Matrices-Transpose-Conjugate transpose- Reversal law for the transpose and conjugate transpose. Adjoint of a matrix, Inverse of a matrix, Singular and Non -Singular matrices,

 **Unit II:** Reversal law for the inverse of product of two matrices. Commutativity of inverse and transopose of matrix, Commutativity of inverse and conjugate transopose of matrix, Orthogonal and Unitary Matrices, Product of unitary matrices, Partitioning of matrices.

**Unit III**  : Rank of a matrix, Echelon form, Rank of transpose, Elementary transformations, Elementary matrices, Invariance of rank through elementary transformations, Reduction to Normal form, Equivalent matrices.

**Unit-IV**: Vector space – Linear Dependence - Basis of a vector space –Sub-space - Properties of Linearly Independent and Dependent systems, Row and Column spaces, Equality of Row and Column ranks, Rank of Sum and Product of matrices

**Unit-V** ; Matrix polynomials, Characteristic roots and vectors,Relation between characteristic roots and characteristic vectors, Algebraic and Geometric multiplicity, Nature of characteristic roots in case of special matrices, Cayley- Hamilton theorem.

**Recommended Text**: Vasishtha.A.R (1972)  :    Matrices, Krishnaprakashan Mandir, Meerut.

**Reference Books:**

1.Shanthinarayan, ( 2012 )  :  A Text Book of Matrices,  S.Chand& Co, New Delhi 2.M.L.Khanna (2009), Matrices, Jai PrakashNath& Co

**Website and e-Learning Source**:

e-books, tutorials on MOOC/SWAYAM courses on the subject

<https://samples.jbpub.com/9781556229114/chapter7.pdf>

<https://www.vedantu.com/maths/matrix-rank>

<https://textbooks.math.gatech.edu/ila/characteristic-polynomial.html>

<https://www.aitude.com/explain-echelon-form-of-a-matrix/>

# **Course Learning Out come(for Mapping with Pos and PSOs)**

Students will be able to

**CLO-1** Do basic operations of matrices

**CLO-2** Understand various transactions of matrices and its applications

**CLO-3** Understand various properties of matrices

**CLO-4** Able to understand vector space and its applications

**CLO-5** Able understand eigen vector and its applications

**CLO-6** Able understand vector and matrix applications

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| **SEMESTER: II****PART: III****CORE COURSE –IV** | **23USTAC24: DISTRIBUTION THEORY** | **Credit:5****Hours:5** |

The main objectives of this course are:

1.To learn discrete distributions

2. To learn continuous distributions

3. to understand Distributions generated from mathematical functions

4. learn normal distribution and its properties

5. understand about sampling distributions

Unit I

Binomial distribution – moments, recurrence relation, mean deviation, mode, moment generating function, characteristic function, cumulants. Fitting of Binomial Distribution. Poisson distribution – moments, mode, recurrence relation, moment generating function, characteristic function, cumulants. Fitting of Poisson distribution. Negative binomial distribution – m.g.f., cumulants. Fitting of Negative binomial distribution.

**Unit II** Geometric distribution – lack of memory, moments, m.g.f.- Hypergeometric distribution – mean, variance, approximation to Binomial, recurrence relation – Multinomial distribution – m.g.f., mean and variance.

**Unit III**  Normal Distribution – chief characteristics of the normal distribution and normal probability curve, mean, median, mode, m.g.f. characteristic function, moments, points of inflexion, mean deviation, Area property – Rectangular distribution – moments, m.g.f., characteristic function, mean deviation about mean.

**Unit-IV** Exponential distribution – m.g.f., characteristic function, memory less property – Gamma distribution – m.g.f., cumulants and central moments, reproductive property – Beta distribution – First kind and second kind – constants.

**Unit-V** Functions of Normal random variables leading to t, Chi-square and F-distributions (derivations, properties and interrelationships).

**Recommended Text:**

1. Gupta, S.C. Kapoor, V.K. (2007) Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi
2. Goon, A.M. Gupta M.K. and Das Gupta B (1977) An Outline of Statistical Theory, Vol I, 6/e, World Press, Calcutta.
3. Hogg, R.V. and Graig, A.T. (1978) : Introduction to Mathematical Statistics, A/e, Mc.Graw Hill Publishing Co.Inc., New York

**Reference Books**

 1.Mood, A.D. Graybill, F.A. and Boes, D.C (1974): Introduction to the Theory of Statistics, 3/e, Mc.Graw Hill, New York.

**Website and e-Learning Source**

 e-books, tutorials on MOOC/SWAYAM courses on the subject

# **Course Learning Outcome(for Mapping with Pos and PSOs)**

Students will be able to

**CLO-1** identify discrete distributions appeared in real life situations

**CLO-2** understand some continuous distributions and its applications

**CLO-3** connection between some of the real values mathematical functions and its application in distribution theory

**CLO-4** understand normal distribution and its properties

**CLO-5**  understand sampling distributions and its applications in real life

**CLO-6** identify probability models in real data and estimate population parameters

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| **SEMESTER: II****PART: III****Elective: II** | **23UNUME25:** **NUMERICAL METHODS-I** | **Credit:3****Hours:4** |

The main objectives of this course are:

1. To introduce the study of algorithms that used numerical approximation for the problems of Mathematical analysis.
2. To solve mathematical problems numerically

**Unit I** : The Solution of Numerical Algebraic and Transcedental Equations: Bisection Method, Iteration Method, Regula Falsi Method, Newton – Raphson Method. Hornor’s Method

**Unit II:** Solution of Simultaneous Linear Algebraic Equations:Guass – Elimination Method, Guass–Jordan Method, Guass – Jacobi Method, Guass –Seidel Method.

Finite Differences: Operators. Interpolation for Equal intervals: Newton’s Forward Interpolation Formula and Newton’s Backward Interpolation Formula, Evaluation of missing terms.

**Unit III:**  Central Difference Interpolation Formula For Equal Intervals:

Guass Forward Interpolation Formula,Gauss Backward Interpolation Formula, Sterlings Formula, Bessel’s Formula, Laplace- Everett’s Formula.

**Unit-IV:** Interpolation with Unequal Intervals:Divided Differences, Newton’s Divided Differences Interpolation Formula, Lagrange’s Interpolation Formula and Inverse Lagrange’s Interpolation, Method of reversal of series.

**Unit-V** :  Numerical Differentiation: Numerical Differentiation based on Newton’s Forward and Backward Interpolation Formula – Computation of Second order derivatives.

Numerical Integration:General Quadrature formula for equidistant ordinates, Trapezoidal Rule,Simpson’s 1/3rd Rule, Simpson’s 3/8th Rule and Weddle’s Rule.

Numerical Solution of Ordinary Differential Equations:Taylor Series Method, Picard’s Method and Runge – Kutta Method. (Simple Problems Only Without Derivation)

**Recommended Text**

1. Kandasamy, P., Thilagavathy, K. (2003): Calculus of Finite Differences and Numerical Analysis, S.Chand Publications.
2. Balasubramaniam and Venkatraman(1972): Numerical mathematics part I and II by Rochouse and Sons

**Reference Books**

1. Kalavathy, S., and Thomson. (2004): Numerical Methods, Vijay Nico::le Publications.
2. Gupta, B.D. (2004): Numerical Analysis, Konark Publications
3. Venkatachalapathy, S.G. (2004): Calculus of Finite Differences and Numerical Analysis, Margam Publications.
4. Gerald Wheatley, (1970): Applied Numerical Analysis, Pearson Education Publications.

 Jain, M.K., Iyengar, S.R., Jain, R.K., (1994): Numerical Methods Problems and Solutions,

 New Age International Publishers

**Website and e-Learning Source:**

 e-books, tutorials on MOOC/SWAYAM courses on the subject [www.nptel.com](http://www.nptel.com)

# **Course Learning Outcome**

Students will be able to

**CLO-1** Solve numerically equations that cannot have direct solution

**CLO-2** solve system of linear equations

**CLO-3** understand the need of interpolation

**CLO-4** handle numerical differentiation

**CLO-5** do integration numerically

**CLO-6** get a foundation on algorithms to solve a mathematical problem

**List of Non – Major Elective offered to other Department**

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| **SEMESTER: I****PART: IV****NME**- **I** |  **23USTAN16: STATISTICAL METHODS I** | **Credit:2****Hours :2** |

**Course Objective(s)**

To enable students to learn basics of statistics and its applications

**UNIT - I**

Statistics - Definitions - limitation of statistics - collection of data - primary data - secondary data - Diagrammatic and Graphical representation of data.

**UNIT - II**

Descriptive Measures - Mean, Median, mode, standard deviation, skewness and kurtosis (ungrouped data only).

**UNIT - III**

Concept of sample and Population - Preparation of questionnaire and Pre-testing - Simple random, Stratified random and Systematic sampling techniques.

**UNIT - IV**

Study of relationship between variables: Concept of correlation - Karl Pearson and Spearman rank correlation - simple problems. Qualitative: Contingency tables - Measures of Association. Concept of simple regression - simple problems.

**UNIT - V**

Elements of Compound interest (nominal and effective rates of interest, annuities certain, present values, accumulated amounts, deferred annuities) - the functions included in compound interest - tables and their uses.

**Text Books:**

1. Gupta,S.P. (2014): Statistical Methods, Sultan Chand& Sons Pvt Ltd. New Delhi.
2. Federation of Insurance Institutes Study Courses - Mathematical Basis of Life Assurances F1,2.

**Reference Books:**

1. Kapoor, V.K. and Gupta, S.P. (1978): Fundamentals of Applied Statistics, Sultan Chand & Sons.

**Course Outcomes**

1. After studied unit - 1, the student will be able to know visualization of data

2. After studied unit - 2, the student will be able to know computations of various statistical measures of data

3. After studied unit - 3, the student will be able to know sample selection and various sampling procedures

4. After studied unit - 4, the student will be able to know relationship among variables and fitting of simple regression model

5. After studied unit - 5, the student will be able to know computation of interest calculations

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| **SEMESTER: II****PART: IV****NME** -**II** | **23USTAN26STATISTICAL METHODS II** | **Credit:2****Hours :2** |

**Course Objective(s)**

To enable students to learn the concept of estimation of unknown parameters of the population and hypothesis testing problem.

**UNIT - I**

Population growth and change - arithmetic, geometric and exponential growth rates - Population estimation and projection.

**UNIT - II**

Measures of mortality - Crude and Specific rates- Infant mortality rate - direct and indirect standardization of death rates - Complete life table.

**UNIT - III**

Estimation - Point estimation - interval estimation - mean - variance - proportions - simple problems.

**UNIT - IV**

Parametric Tests - Testing of significance of small and large sample tests - t-test, chi-square test - F test - z-test.

**UNIT - V**

Non- Parametric tests - Sign test, Wilcoxon test, Mann-Whitney U Test. Median test, Run test, Kolmogorov - Smirnov One Sample test. Chi- Square Tests - Goodness of fit - Test of independence of attributes.

**Text Books:**

1. Gupta,S.P (2014): Statistical Methods, Sultan Chand & Sons .

2**.** Kapoor, V.K. and Gupta, S.P. (1978): Fundamentals of Applied Statistics, Sultan Chand & Sons.

**Reference Books:**

1. Rohatgi, V.K. (1984) An introduction to probability theory and Mathematical Statistics, Wiley Eastern.

**Course Outcomes**

**CLO**1. After studied unit - 1, the student will be able to know computation of population growth rate

**CLO**2. After studied unit - 2, the student will be able to know the concept of mortality and its calculations

**CLO**3. After studied unit - 3, the student will be able to know the concept of estimation of parameter

**CLO**4. After studied unit - 4, the student will be able to know various parametric testing procedures

**CLO** 5. After studied unit - 5 , the student will be able to know various Non parametric testing procedures

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| **SEMESTER: III****PART: III****CORE - V** | **23USTAC33 - ESTIMATION THEORY** | **Credit:5****Hours :5** |

**Pre-requisite :** Number theory and Arithmetic Objectives of the CourseThe main objectives

of this course are:

1. To Emphasize on the Concept of Point Estimation and Interval Estimation.
2. To learn properties of a good estimator
3. To understand various methods of estimation

Unit I   Point estimation – Estimator – Consistency and Unbiased ness – Efficiency and asymptotic efficiency – Estimators based on sufficient statistics – Neyman Factorization theorem (statement only) – Simple illustrations

**Unit II** Minimum variance unbiased estimators – Cramer – Rao Inequality – Rao Blackwell theorem – Simple illustrations

**Unit III**  Methods of Estimation – Methods of Maximum likelihood and moments – Properties of estimators obtained by these methods – Simple illustrations

**Unit-IV** Method of Minimum Chi-Square-Method of Minimum Variance-Methods of moments -Methods of Least squares- Interval estimation.

**Unit-V**  Notion of Bayes estimation – concept of prior, posterior and conjugate priors. Simple problems involving quadratic error loss function – Notion of Mini max estimation – Simple illustrations.

Skills acquired from this course Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

1. Recommended Text Gupta S.C. and Kapoor V.K. (2007): Fundamentals of Mathematical Statistics, Sultan Chand Sons, New Delhi.
2. P.R. Vittal (2002) : Mathematical Statistics, Margham Publications, Chennai.
3. Ashok K. Bansal (2007): Bayesian Parametric Inference, Narosa Publishing House.
4. Mood, A.M. Graybill, F.A. and Boes D.C. (1974): Introduction to Theory of Statistics, McGraw – Hill.

Reference Books

1. Rohatgi, V. (1976) : An Introduction to Probability Theory and Mathematical Statistics,

 Wiley Eastern.

1. Goon A.M. Gupta M.K. and Das B. (1980): An Outline of Statistical Theory, Vol II, World Press, Calcutta
2. Sanjay Arora and BansiLal (1989) : New Mathematical Statistics, SatyaPrakasam, New Delhi.
3. Hodges, J.L. and Lehman, E.L (1964): Basic Concepts of Probability and Statistics, Holden Day.
4. Dr. A. Santhakumaran(2004): Probability Models and their Parametric Estimation

 Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the

 subject

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| **SEMESTER: III****PART: III****CORE - VI** | **23USTAC34 - SAMPLING TECHNIQUES** | **Credit:5****Hours :5** |

**Pre-requisite:** Descriptive statistics and Probability theory

**Objectives of the Course** The main objectives of this course are:

1. To know the basic operations of sampling
2. To study the theory and applications of SRS
3. To learn practical uses of Stratification
4. To apply Systematic and PPS Sampling in real time problems.

Unit I Basic concepts of sample surveys – Advantages of Sampling –Principal steps in Sample survey, Sampling unit – Sampling frame – Census – Probability Sampling, Alternatives to probability sampling, Mean Square Error.

**Unit II** Simple random sampling, Methods of selection, Sampling with and without replacement – Properties of estimates, Finite population correction, Estimation of Standard error, Confidence limits – Simple random sampling for Qualitative characteristics, Sample size determination for proportions and continuous data. Design effect.

**Unit III**  Stratified random sampling, principles of stratification, Notations – Estimation of population mean and its variance – Estimated variance and confidence limits, Allocation techniques -equal allocation, proportional allocation, Neyman allocation and optimum allocation, Estimation of gain due to stratification. Estimation of sample size for continuous data.

**Unit-IV**Systematic sampling –Relation to cluster sampling, Estimation of population mean and its sampling variance – Comparison of systematic sampling with stratified random samples.Systematic sampling in two dimensions.

**Unit-V**   Varying Probability sampling, Selection of one unit with PPS, PPS Sampling with replacement, Estimator for population total and its variance, Selection procedures, Cumulative total method, Lahiri’s method, Split method.

Skills acquired from this course Knowledge ,Problem Solving, Analytical ability ,Professional

Competency, Professional Communication and Transferrable Skill

**Recommended Text**

1.Cochran, W.G. (1978) : Sampling Techniques, John Wiley Eastern

2Murthy M.N. (1967):Sampling Theory and Methods, Statistical Publishing Society, Calcutta

**Reference Books**

1.Singh. D. and ChaudryF.S. (1986) : Theory and Analysis of Sample Surveys Design Wiley Eastern Ltd.

2.Sampath.S, (2001), Sampling Theory and Methods, CRC Press.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

<http://ocw.jhsph.edu/courses/statmethodsforsamplesurveys/pdfs/lecture2.pdf>

<https://www.questionpro.com/blog/stratified-random-sampling/>

<https://www.scribbr.com/methodology/systematic-sampling/>

<http://home.iitk.ac.in/~shalab/sampling/chapter7-sampling-varying-probability-sampling.pdf>

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| **SEMESTER: III****PART: III****ELECTIVE - III** | **23USTAE35- REAL ANALYSIS** | **Credit:3****Hours :4** |

**Pre-requisite** Number theory and Arithmetic

**Objectives of the Course** The main objectives of this course are:

1. To study the basic operations of sets and functions
2. To know the structure of the real sequence and its convergence
3. To learn series and its convergence
4. To learn the limits, continuity and derivative of real valued functions
5. To know and to apply the Riemann integration

Unit I Operations on sets, Functions, Real valued functions, Equivalence, Countability, Real Numbers, Cantor set, Least Upper Bounds, Greatest Lower Bound.

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**Unit II** Definition of Sequence, Subsequence, Limit of a sequence, Convergent and Divergent sequences, Oscillating sequence, Bounded and Monotone sequences, Operations on convergent sequences, Limit Infimum, Limit Supremum, Cauchy sequences, Summability of sequences.

**Unit III**  Definition of Series, Convergent and Divergent series, series with nonnegative terms, alternating series, conditional convergence, absolute convergences and test for absolute convergence

**Unit-IV** Limit of a function on the real line, Increasing and Decreasing functions, Continuous function, Operations on continuous functions, Composition of continuous functions, Derivatives, Derivative and continuity, Rolle’s Theorem, Mean value theorem, Taylor’s theorem

**Unit-V** Concept of Riemann Integral, Refinement of partition, Upper and Lower sums, Upper integral and Lower Integral Riemann integrability, Necessary and Sufficient condition for Riemann integrable, Properties of Riemann integrals, Fundamental theorem

Skills acquired from this course Knowledge ,Problem Solving, Analytical ability , Professional

Competency, Professional Communication and Transferrable Skill

1. **Recommended Text:** Goldberg .R R(1976)   :    Methods of Real Analysis, Oxford &IBH. **Reference Books**

1.Shanthi narayan, ( 2012 )  :  Real Analysis,  S.Chand& Co, New Delhi

2.Walter Rudin (2017), Principles of Mathematical Analysis, 3rd Edition, McGraw-Hill

 Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

<https://tutorial.math.lamar.edu/classes/calci/thelimit.aspx>

<https://www.mathsisfun.com/calculus/derivatives-introduction.html>

<https://www.math.ucdavis.edu/~hunter/m125b/ch1.pdf>

[https://math.hmc.edu/calculus/hmc-mathematics-calculus-online-tutorials/single-variable calculus/taylors-theorem/](https://math.hmc.edu/calculus/hmc-mathematics-calculus-online-tutorials/single-variable%20calculus/taylors-theorem/)

<http://www.ms.uky.edu/~droyster/courses/fall06/PDFs/Chapter06.pdf>

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| **SEMESTER: III****PART: IV****SKILL ENHANCEMENT-IV** | **23USTAS36- DATABASE MANAGEMENT SYSTEM** | **Credit:1****Hours :1** |

**Course Objective(s)**

To enable the students to understand classifying and grouping and retrieve the mass data.

**UNIT - I**

Introduction - DBMS Basic Concepts - Purpose of Database Systems - Database System/ File System - Overall System architecture - Database Languages - Classifications - Data Models.

**UNIT - II**

Entity relationship model: Mapping constraints - Primary Keys - Foreign Key - Structural Constraints - ER notations - ER model examples - Enhanced Entity Relationship Model: EER Concepts like Generalization, Specialization, Union, Category, Disjoint, Overlapping etc.EER model examples.

**UNIT - III**

Relational Data Base Design - ER/EER to Relational Mapping algorithm - Relational Model: Structure - Formal Query Languages - Relational Algebra - Informal Design Guidelines - Functional Dependencies - Normalization upto third Normal Form.

**UNIT - IV**

SQL - Basics of SQL - DDL - DML - DCL - TCL Commands in detail with examples.

**UNIT - V**

PL/SQL: Stored Procedure Concepts - Procedure - Functions - Cursors - Triggers.

Skills acquired from this course Knowledge ,Problem Solving, Analytical ability ,Professional

Competency, Professional Communication and Transferrable Skill

**Text Books:**

1. H.F. Korth and A.Silberschatz (1988): Database system Concept, McGraw Hill Publication.
2. Albert Lulushi (1997): Developing ORACLE FORMS Applications, Prentice Hall

**Reference Books:**

1. Ramez Elmasri and B. Navathe, Fundamentals of Database Systems (Chapters 1, 2, 3, 4.1, 7, 8, 9, 14), 3/e, Addison Wesley.

**Course Outcomes**

1. After studied unit - 1, the student will be able to know structure of DBMS.

2. After studied unit - 2, the student will be able to know the concept of entity relationship models

3. After studied unit - 3, the student will be able to know relational data based designs

4. After studied unit - 4, the student will be able to know standard query language

5. After studied unit - 5, the student will be able to know the concept of PL/SQL

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| **SEMESTER: III****PART: IV****SKILL ENHANCEMENT-V** | **23USTAS37- STATISTICAL DATA ANALYSIS-I**  | **Credit:2****Hours :2** |

**Course Objectives**

1. To acquire the knowledge to solve problems related to descriptive Statistics.

2.To acquire the knowledge to solve problems related to Probability and distribution,.

**Practical Schedule: -**(Based on Core Paper I,II,&IV)

1. Calculation of Mean, Median, Mode, Geometric Mean and Harmonic Mean for raw data.

2. Calculation of Mean, Median and Mode for discrete data.

3. Calculation of Mean, Median and Mode for frequency distribution with Class Intervals.

4. Calculation of raw and central moments for raw data.

5. Calculation of raw and central moments for frequency distribution.

6. Calculation of range, Quartile Deviation, Standard Deviation, Mean Deviation, Coefficient of

Variation and Variance for raw data.

7. Calculation of range, Quartile Deviation, Standard Deviation, Mean Deviation, Coefficient of

Variation and their relative measures for frequency distribution.

8. Calculation of Pearson’s, Bowley’s Coefficient of Skewness and Kelly’s Coefficient of Skewness.

9. Calculation of Simple Correlation, Rank Correlation and Regression Coefficients.

10. Forming of Regression Lines and Predictions from Bivariate Data.

11. Construction of contingency table.

12. Association of Attributes.

13. Join Probability mass function, Join probability density function, Marginal probability mass and density functions.

14. Expectation, variance and Correlation coefficient. Distributions-discrete and continuous distributions

Skills acquired from this course Knowledge ,Problem Solving, Analytical ability , Professional Competency, Professional Communication and Transferrable Skill

**Text Books**

Books prescribed in the respective core papers shall be used.

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| **SEMESTER: III****PART: IV****EVS** | **ENVIRONMENTAL STUDIES** | **Credit:-****Hours :1** |

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| **SEMESTER: IV****PART: III****CORE: VII** | **23USTAC43 TESTING OF STATISTICAL HYPOTHESIS** | **Credit:5****Hours :5** |

**Pre-requisite** Estimation theory and distribution theory

**Objectives of the Course** The main objectives of this course are:

1. To make familiar with testing concepts
2. To understand the concept of Most Powerful test
3. To understand the Likelihood ratio tests and their uses
4. To apply tests for samples from unknown distributions

Unit I

Statistical Hypothesis – Null and Alternative Hypothesis – Simple and Composite hypothesis – Critical region – Type-I and Type-II error – Most Powerful test – Uniformly Most powerful test – Neyman Pearson Lemma – Simple problems.

**Unit II**

Likelihood ratio test – Tests of mean of a normal population – Equality of two means of normal populations – test for variance of a normal population – Equality of variances of two normal populations.

**Unit III**

Chi-square tests, Distribution of quadratic forms, Test of equality of several means, Analysis of Variance. Correlation and Regression testing.

**Unit-IV**

Exact tests based on t distribution – One sample tests - one sided and two sided tests – Variance known and Variance unknown – Two sample tests – One sided and two sided - Variance known and Variance unknown.

**Unit-V**

Nonparametric methods – Confidence interval for distribution quantiles – Tolerance limits for distributions. Sign test, Wilcoxon test.

Skills acquired from this course Knowledge, Problem Solving, Analytical ability ,Professional

Competency, Professional Communication and Transferrable Skill

**RECOMMENDED TEXT**

1. Robert V. Hogg and Allen T.Craig (1978), Introduction to Mathematical Statistics, 4th edition, Macmillan Publishing Co., Inc. New York

An Introduction to Probability and Statistics (2001), Rohatgi.V.K, and A.K.Md.EhsanesSaleh, John Wiley & Sons

**REFERENCE BOOKS**

1. Gupta S.C. and Kapoor V.K. (1991) : Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
2. Goon A.M. Gupta M.K. and Das Gupta B (1980) : An outline of Statistical Theory, Vol.II World Press Calcutta.
3. Mood A.M. Gray bill F.A. and Boes D.C.B (1980) : Introduction to the Theory of Statistics 3/e, McGraw Hill, New York.
4. Gibbons, J.D. (1971) : Non-Parametric Statistical Inference, McGraw Hill.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

<http://fisher.stats.uwo.ca/faculty/kulperger/SS3858/Handouts/np-lemma.pdf>

<https://www.sciencedirect.com/topics/mathematics/uniformly-most-powerful-test>

<https://www.probabilitycourse.com/chapter8/8_4_5_likelihood_ratio_tests.php>

<https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/parametric-and-non-parametric-data/>

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| **SEMESTER: IV****PART: III****CORE: VIII** | **23USTAC44 STATISTICAL QUALITY CONTROL**  | **Credit:5****Hours :5** |

**Pre-requisite** Estimation theory and Distribution theory

**Objectives of the Course** The main objectives of this course are:

1. To impart basic theoretical knowledge about terminologies, need of control charts for quality control, construct control limits of variables and attributes.
2. To educate the learner to be able to construct control charts for defects, number of defects (c-

 chart); and control chart for number of defects per unit (u-chart).

1. To educate acceptance sampling plan and discuss the procedure of its implementation,  compute the probability of accepting or rejecting a lot.
2. To define acceptance quality level (AQL) and lot tolerance percent defective(LTPD) of the lot; and  compute the producer’s risk and consumer’s risk for an acceptance sampling plan.
3. To facilitate the learner to understand the difference between attributes and variables sampling plans, the advantages and disadvantages of variables sampling.

Unit I

Importance and need for Statistical Quality Control techniques in Industry – Causes of variations in Quality – Uses of Shewart’s Control charts –Terminologies: Specification limits, Tolerance limits, 3σ limits and Warning limits – Theory of runs and its applications in Quality control. Basis of sub grouping – Advantages and Limitations of SQC -Control charts variables: Control Chart for Mean (Xbar- Chart) ,Range Chart (R-Chart) , Standard Deviation Chart (S-Chart) - Process Capability Analysis

**Unit II**

Control Charts for Attributes: Control Chart for Fraction Defective (p-Chart) ,p-Chart for Variable Sample Size , Control Chart for Number of Defectives (np-Chart). Control Charts for Defects: Control Chart for Number Of Defects (C-Chart)and Control Chart for Number Of Defects Per Unit (U-Chart).

**Unit III**

Acceptance sampling plans for attributes –Types of Acceptance Sampling plans, Methods of Inspection: 100% Inspection and Sampling Inspection , Advantages and Limitations of Acceptance Sampling. Terms used in acceptance sampling plans: Lot, Lot Size, Sample Size, Lot Quality, Acceptance Number , Probability of accepting a lot (Pa) , Acceptance Quality Level (AQL), Lot Tolerance Percent Defective (LTPD), Producer’s Risk, Consumer’s Risk, AOQ, AOQL, ATI and ASN.

**Unit-IV**

Rectifying Sampling Plans. Single and Double sampling plans. OC, AOQ, ATI and ASN curves for Single and Double sampling plans.

**Unit-V**

 Acceptance sampling for variables known and unknown sampling plans (one sided specification only) -Determination of n and k for one sided specification of OC curve

Skills acquired from this course Knowledge, Problem Solving, Analytical ability, Professional

Competency, Professional Communication and Transferrable Skill

Recommended Text

1. Douglas C. Montgomery (2005) : Introduction to Statistical Quality Control, John Wiley & Sons, New York.

( Unit V: Chapter 16 ( pages 670 to 680)

1. Gupta S.C and V.K.Kapoor (2007): Fundamentals of Applied Statistics, Sultan Chand Sons, New Delhi
2. Mahajan, M (1998) : Statistical Quality Control, DhanpatRao& Co, New Delhi.

**Reference Books**

1 Gupta, R.C.(1974): Statistical Quality Control.

2. Ekambaram, S K. (1963): Statistical basis of Acceptance sampling, Asia

 Publishing House.

3. Grant, E,L. and Laven Worth, R.S.: Statistical Quality Control, McGrawHill.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

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| **SEMESTER: IV****PART: III****ELECTIVE: IV** | **23USTAE45 OFFICIAL STATISTICS** | **Credit:3****Hours :3** |

**Objectives of the Course** The main objectives of this course are:

1. To understand the statistical systems.
2. To understand the official statistical system.
3. Understand the functioning of government and policies.
4. Promote human resource development in the official statistics and encourage research and development in theoretical and applied statistics.
5. Execute the data handling tasks in various government records

**Unit - I**

Official Statistics: Definition – Growth of Indian Statistics – Statistical organizations of India: Central Statistical Organisation (CSO) – Divisions of Central Statistical Organisation – Functions – Publications.

**Unit - II**

National Sample Survey Organisation (NSSO) – Divisions of NSSO – Functions of NSSO – Procedure for collection of information – Agriculture Statistics, Yield Statistics – Official series: Traditional method, Random Sampling Method – NSS Series – Forest Statistics, Fisheries Statistics – Defects in agricultural Statistics.

**Unit - III**

National income: Definition – Methods of estimating national income: The Income method, the Output method and the Expenditure method – Uses of National income estimates – Difficulties of estimation.

**Unit - IV**

Social accounting – Population statistics – Sources – Different methods of collecting population census – Methods of enumeration – Merits and demerits of De Facto method, Merits and demerits of the De Jure system.

**Unit - V**

Price Statistics: Wholesale prices, Retail prices, Uses and limitations of price statistics. Industrial Statistics: Main Sources of industrial Statistics – Limitations.

**RECOMMENDED TEXT**

1. Allen R. G. D. (1975). Index Numbers in Theory and Practice, Macmillan.
2. Mukhopadhyay, P. (2011). Applied Statistics, Second Edition, Books & Allied Ltd, India.
3. Basic Statistics Relating to the Indian Economy (CSO),1990.
4. Family Welfare Yearbook.Annual Publication of D/o Family Welfare.
5. Guide to Official Statistics (CSO), 1999.
6. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.
7. Principles and accommodation of National Population Censuses, UNESCO.
8. Statistical System in India (CSO) 1995.

**REFERENCE BOOKS**

1. Bhaduri, A. (1990). Macroeconomics: The Dynamics of Commodity Production, Macmillan India Limited, New Delhi.
2. Branson, W. H. (1992). Macroeconomic Theory and Policy, Third Edition, Harper Collins Publishers India (P) Ltd., New Delhi.
3. Goon A. M., Gupta M. K., and Dasgupta. B. (2001), Fundamentals of Statistics, Vol. 2, World Press, India.
4. Panse, V. G. (1964). Estimation of Crop Yields (FAO), Food and Agriculture Organization of the United Nations.

Website and e-Learning Source e-books

1. https://www.classcentral.com/course/swayam-macro-economics-19942
2. https://www.classcentral.com/course/swayam-economics-of-health-and-health-care-14023
3. www.mospi.nic.in and censusindia.gov.in

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| **SEMESTER: IV****PART: IV****SKILL ENHANCEMENT- 6** | **23USTAS46 STATISTICAL DATA ANALYSIS-I (USING R PROGRAMMING)** | **Credit:2****Hours :2** |

**Course Objective(s)**

To enable students to utilize the theoretical knowledge gained in the core papers and to develop computational and technical skills for real life applications emphasizing the importance of R programming.

Problems relating to the following topics shall form the basis for the practical.

1. Using R command-Operations on vectors and matrices. Creating and Manipulation of data frames - user-defined functions.
2. Matrix addition, multiplication, inverse, transpose, determinant and trace of matrix.
3. Construction of table with one or more variables. Graphical procedures– Pie chart, Bar chart, Histograms and Boxplots.
4. Computation of various descriptive measures such as Measures of central tendency, measures of dispersion, skewness and kurtosis. Computation of correlations and regression co-efficient.
5. Computation of probabilities using various distributions Binomial, Poisson and Normal
6. selection of samples using various sampling techniques, methods and procedures

Skills acquired from this course Knowledge, Problem Solving, Analytical ability, Professional

Competency, Professional Communication and Transferrable Skill

**Text Books**

Purohit, S. G., Gore, S. D., and Deshmukh, S. R. (2009). Statistics Using R, Narosa Publishing House, NewDelhi.

**E-Resources**

[www.r-project.org](http://www.r-project.org)

**Course Outcomes**

At the end of the course, the student will be able to:

1. Understand the various concepts of statistical tests and to apply large sample tests.

2. Apply the exact tests for research problems.

3. Apply the various chi-square tests.

4. Apply the multiple regression analysis and multivariate tests for real life problems.

5. Apply the non-parametric tests for sample data.

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| **SEMESTER: IV****PART: IV****SKILL ENHANCEMENT- 7** | **23USTAS47 STATISTICAL DATA ANALYSIS-I (USING SPSS)** **STATISTICS PRACTICAL (SOFTWARE BASED)** | **Credit:2****Hours :2** |

**Course Objectives**

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| 1.To enable students to utilize the theoretical knowledge gained in the core papers and to develop computational and technical skills for real life applications emphasizing the importance of statistical software programming. |

**Practical Schedule:**

To compute the various statistical measures using statistical software SPSS.

1. Tabulation and diagrammatical representation of data.
2. Measures of Central Tendency, Dispersion, Skewness and Kurtosis
3. Correlation and Regression, simple and multiple linear regression.
4. Parametric tests: t-test, F-test, chi-square test.
5. Analysis of variance: One-way Classification, Two-way Classification.
6. Non-parametric tests: Sign test, Wilcoxon test, Mann-Whitney U test, Median test, Run test, Kolmogorov Smirnov test, Kruskal Wallis test.

**Text Books**

Books prescribed in the respective core papers shall be used.

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| **SEMESTER: IV****PART: IV****EVS** | **23UEVSG48** **ENVIRONMENTAL STUDIES** | **Credit:2****Hours :1** |

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| **SEMESTER: V****PART: III****CORE: IX** | **23USTAC51****STOCHASTIC PROCESSES** | **Credit:4****Hours :5** |

**Objectives of the Course** The main objectives of this course are:

1. To study the basic concepts of theory of Stochastic Processes, the most important types of Stochastic Processes, various properties and characteristics (Poisson, Morkov and others).
2. To learn the notions of ergodicity, stationarity and applications.

 **Unit I** Notion and specification of Stochastic Processes – Stationary Process – Markov Chains

– Definition and examples – Higher transition probabilities: Chapman – Kolmogorov equations.

 Classification of States and Chains

**Unit II** Markov Chains – Determination of Stability of a Markov System – Limiting Behaviour – Ergodic theorem. One dimensional random walk

**Unit III** Markov Processes with discrete state space: Poisson Process – Postulates of Poisson process Properties of Poisson Process – Poisson process and related distributions. Pure Birth process – Yule-Furry process.Pure Death Process – Simple Birth and Death Process.

**Unit-IV** Renewal Process – Definition, related concepts and examples – Renewal equation – Elementary Renewal Theorem – Basic Renewal Theorem.

**Unit-V** Applications in Stochastic Models: Queuing Systems and Models: Simple queuing models M/M/1, M/M/s queuing systems (finite and infinite) steady state solution-simple problems with finite and infinite capacities.

**RECOMMENDED TEXT**

1. Medhi, J. (2019): Stochastic Processes, New Age International Publishers.
2. Kanti Swarup, Gupta.P.K. Man Mohan.,(2010): Operations Research, Sultan Chand & Sons

**REFERENCE BOOKS**

1. Karlin ,S. and Taylor, H.M.(1975): A first Course in Stochastic Processes, Academic Press, New York.

2. Ross, S.M. (1983): Stochastic Processes. John Wiley Eastern Ltd., New York.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

http://www.randomservices.org/random/

 <https://www.britannica.com/science/stochastic-process>

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| **SEMESTER: V****PART: III****CORE: X** | **23USTAC52****REGRESSION ANALYSIS** | **Credit:4****Hours :5** |

**Pre-requisite:** Linear regression analysis, Estimation theory

**Objectives of the Course:** The main objectives of this course are:

1. To understand linear and nonlinear relationships between variables and training the students in applications oriented.
2. To teach Linear Regression models, its assumptions and its properties.
3. To perform model adequacy check before using Linear Regression models
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 Unit I Simple linear regression-Assumptions, estimation of model parameters, standard error of estimators, testing of hypotheses on slope and intercept ( β’s), interval estimation of model parameters, prediction interval of a new observation, coefficient of determination, regression through origin.

 **Unit II** Standard Gauss Markov setup, least square estimation of model parameters, variance covariance of least squares estimators, estimation of error variance

 Tests of hypotheses – significance of regression (ANOVA, R2and adjusted R2), individual regression coefficients, subset of regressor variables, general linear hypotheses- Confidence intervals and regions, prediction intervals, detecting hidden interpolation.

 **Unit III**  Model adequacy checking - residual plots for checking normality homoscedasticity and detection of outliers. Test for Lack of fit of the model. Durbin – Watson test for autocorrelation. Analytical methods for selecting a transformation generalized and weighted least squares- Detection of influential observations – Cooks statistic, DFFITS, DFBETAS.

 Variance stabilizing transforms and transforms to linearize the model, analytical methods for selecting a transform, generalized and weighted least squares.Dummy (or indicator variables) – general concepts and their use

 **Unit-IV** Multicollinearity – sources, effects, diagnostics, Methods of dealing with multi collinearity (collection of additional data, model respecification, Ridge regression).

Selection of Variables – forward selection, backward elimination and stepwise regression (algorithms only)

 **Unit-V** Nonlinear regression – transformation to a linear model, their use and limitations, initial estimates (starting values), parameter estimation using iterative procedures – Gauss-Newton, steepest Descent, Marquardt’s compromise.

 Count data- Poisson Regression – variables selection- Non –parametric regression.

**RECOMMENDED TEXT**

1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introductionto Linear regression analysis, third edition, John Wiley and Sons,Inc.
2. Zar, J.H. (2006): Biostatistical Analysis, fourth edition, Pearsoneducation.
3. Douglas C. Montgometry (2012)Introduction to Linear Regression Analysis.
4. Iain Pardoe (2012): Applied regression Modeling, second edition,Wiley

**REFERENCE BOOKS**

1. Draper, N.R. and Smith, H. (2003): Applied Regression Analysis,third edition, John Wiley and Sons,Inc.
2. Johnston, J. (1984): Econometric methods, third edition, McGrawHill International.
3. A. Sen, M. Srivastava, Regression Analysis — Theory, Methods, and Applications, Springer-Verlag, Berlin,2011.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

[http://home.iitk.ac.in/~shalab/regression/Chapter2-Regression-SimpleLinearRegressionAnalysis.pdf](http://home.iitk.ac.in/~shalab/regression/Chapter2-Regression-%20SimpleLinearRegressionAnalysis.pdf)

<http://www.mit.edu/~6.s085/notes/lecture3.pdf>

[https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Nonlinear\_Regression.pdf](https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/%20NCSS/Nonlinear_Regression.pdf)

<https://data.princeton.edu/wws509/notes/c4.pdf>

<http://home.iitk.ac.in/~shalab/regression/Chapter15-Regression-PoissonRegressionModels.pdf>

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| **SEMESTER: V****PART: III****CORE: XI** | **23USTAP53****PRACTICAL COVERING : (CORE VIII ,IX & X)** | **Credit:4****Hours :5** |

**Practical Schedule:**

Statistical Quality control charts for variables Statistical Quality control charts for attributes

Control chart for variables - X-bar chart, R chart, σ chart - purpose of the charts - Basis of sub grouping - plotting X-bar and R results - determining the trial control limits - X-bar and R.

Control chart for attributes - purpose of the chart - p chart - np chart - construction of p and np chart - choice between chart for P and chart for np - construction of c-chart.

Acceptance of sampling plans for attributes - Producer's risk and consumer's risk - concepts of AQL, LTPD, AOQ, AOQL, ATI and ASN - single, double and Multiples sampling plans - OC, AOQ, ATI curves for single and double sampling plans.

Variable sampling plans - Sigma known and sigma unknown determination of n and k for one sided specification - OC curve.

Transition probability matrices

Classification of states problems

Applications in Stochastic Models: Queuing Systems and Models

Tests of hypotheses – significance of regression (ANOVA, R2and adjusted R2), individual regression coefficients, subset of regressor variables, general linear hypotheses- Confidence intervals and regions, prediction intervals, detecting hidden interpolation

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| **SEMESTER: V****PART: III****CORE: XII** | **23USTAD54****PROJECT WITH VIVA- VOCE**  | **Credit:4****Hours :5** |

**Course Objective(s)**

To enable students to utilize the theoretical knowledge gained in the core papers and to develop computational and technical skills for real life applications by collecting primary / secondary data and performing analyses and submitting their findings in the form of dissertation / project.

**Note**

All the admitted candidates shall have to carry out a project work during the fifth semester under the supervision of the faculty of the Department of Statistics in the College. The core project should be individual . Candidates shall have to submit three copies of the report of the project work at the end of the fifth semester at least two weeks before the last working day and shall have to appear for a viva-voce examination.

The report shall be evaluated and viva-voce examination shall be conducted jointly by an External Examiner and the Project Guide.

The maximum marks for the project report and viva – voce examination shall be fixed as 100, which is split with the following components:

Internal Assessment Marks by the Project/Dissertation Guide : 25 marks

Evaluation of Project/Dissertation Report jointly by the : 50 marks

External Examiner and the Guide

Conduct of Viva-Voce Examination by the external examiner : 25 marks

**(Refer to the Regulations for additional Information)**

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| **SEMESTER: V****PART: III****ELECTIVE: V** | **23USTAE55****OPERATIONS RESEARCH** | **Credit:3****Hours :4** |

**Pre-requisite** Linear algebra

**Objectives of the Course** The main objectives of this course are:

1. Optimization techniques
2. Transportation problems
3. Game theory
4. Replacement problems
5. Network analysis

Unit I

Formulation of Linear programming models – Graphical solution of LPP in two variables – LPP in standard form – Principles of Simplex method – Algorithm – Need for artificial variables – Charne’s M-Technique – Concept of degeneracy.

**Unit II**

Transportation problem(TP) – TP formulation- North-West Corner, Least cost, Vogel’s Approximation method – UV-method – Assignment problem and algorithm.

**Unit III**

Theory of Games – Basic definition – Maximin and Minimax criterion – Solution of Games with saddle points – Two–by–Two (2x2) Games without saddle point – principle of dominance – problems based on dominance rule – Graphical method for (2xn) and (mx2) games.

**Unit-IV**

Replacement problems – Replacement policy for items whose maintenance cost increases with time and the value of money remains constant – Replacement policy for items whose maintenance cost increases with time and the value of money also changes with time – Replacement of items that fail completely – Group replacement policy

**Unit-V**

Network analysis by CPM/PERT : Basic Concept – Constraints in Network – Construction of the

 Network – Time calculations – Concept of slack and float in Network Analysis – Network crashing –

 Finding optimum project duration and minimum project cost.

**RECOMMENDED TEXT**

1. KantiSwarup, P.K. Gupta and Manmohan (2007) Operations Research, Sultan Chand Sons, New Delhi.
2. S.D. Sharma (2002) : Operations Research: Kedarnath and Ramnath, Meerut.

J.K. Sharma (2002) : Operations Research: Theory and application , Macmillan, India Ltd.

**REFERENCE BOOKS**

1. Taha : Operations Research, PHI.
2. F.S. Hiller and Liberman (1994): Operations Research, CBS Publishers and Distributions, New Delhi.

 Website and e-Learning Source, e-books, tutorials on MOOC/SWAYAM courses on the subject

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| **SEMESTER: V****PART: III****ELECTIVE: VI** | **23USTAE56****ECONOMETRICS** | **Credit:3****Hours :4** |

**Objectives of the Course** The main objectives of this course are:

 1. to Know the Scope and objectives of Econometrics

 2. Understand models of Econometrics and estimation of parameters of econometric models.

 3. Understand the multi collenearity and auto correlation

**UNIT-I**

Introduction: Definition, scope, economic and econometric models-Aim and methodology of econometrics. Linear models - Endogenous and Exogenous variables – assumptions-structural forms and reduced forms. Ordinary Least Square Estimators (OLS) and its properties

**UNIT-II**

Assumptions of Classical Linear Regression Model (CLRM). Heteroskadasticity: Meaning, detection, consequences. Solutions to the Heteroskadasticity problem. Testing the linear versus Log linear functional form – Concept of Box- Cox test.

**UNIT-III**

Autocorrelation: Meaning, sources and consequences- Test for autocorrelation-Durbin – Watson test, Estimation in levels verses first differences. Correlelogram: Correlelogram of moving averages-correlelogram of auto-regressive series.

**UNIT-IV**

Multicollinearity: Meaning, assumptions and consequences, Measures of Multicollinearity, Problems with measuring Multicollinearity, solutions to multocolinearity problem: Ridge Regression. Concept of principal component regression and dropping variables.

**UNIT-V**

Simultaneous Equation models: Identification through Reduced form, Necessary and sufficient condition for identification. Methods of estimation: The instrumental variable method, Two stage least square method.

**RECOMMENDED TEXT**

1. Damadar N. Gujarati and Sangeetha, Basic Econometrics.
2. Maddala, G.S., Introduction to Econometrics, Third edition, John Wiley’s and Sons Ltd.

**REFERENCE BOOKS**

1. Madnani, G.M.K. (2008). Introduction to Econometrics: Principles and Applications. Oxford and IBH Publishing.
2. Johnston, J., and J. DiNardo,.( 1997). Econometric Methods, McGraw-Hill.

Website and e-Learning Source

1. [http://bseu.by/russian/faculty5/stat/docs/4/Creel,Graduate%20Econometrics.pdf](http://bseu.by/russian/faculty5/stat/docs/4/Creel%2CGraduate%20Econometrics.pdf)
2. <https://www.youtube.com/watch?v=_94uwySaKlU>
3. <https://www.youtube.com/watch?v=YclJm2zymsg>
4. https://www.dynamictutorialsandservices.org/2014/05/business-economics-meaning-nature-scope.html

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| **SEMESTER: V****PART: IV****VALUE EDUCATION** | **23UVALG57****VALUE EDUCATION** | **Credit:2****Hours :2** |

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| **SEMESTER: V****PART: IV** | **23USTAI58****SUMMER INTERNSHIP** | **Credit:2****Hours :-** |

**(Refer to the Regulations)**

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| **SEMESTER: VI****PART: III****CORE: XIII** | **23USTAC61****DESIGN OF EXPERIMENTS** | **Credit:4****Hours :6** |

**Pre-requisite** Linear models

**Objectives of the Course** The main objectives of this course are:

1. To get theoretical knowledge in Statistical Design of Experiments and analysis of variance
2. To build strong theoretical foundation in Orthogonal latin squares, Hyper Graeco Latin squares, factorial and fractional factorial experiments, PIBD, inter and intra blocks, split plot, analysis covariance, Response surface methodology
3. To develop analytical thinking in problem solving skills

Unit I Fundamental Principles of Experiments – Replication, Randomization and Local Control techniques – Size of experimental unit – Methods of determination of experimental units – (Maximum curvature method – Fairfield Smith’s variance law).

**Unit II** Analysis of variance – One way, Two way, classification (without interaction) – Multiple range test; Newman-Keul’s test – Duncan’s multiple range test – Tukey’s test – Transformation – Square root, angular and log transformations.

**Unit III**  Completely Randomized Design (CRD) and its analysis – Randomized block design (RBD) – RBD – More than one but equal number of observations per cell – Latin Square Design (LSD) and its analysis.

**Unit-IV** Missing plot techniques – Meaning – Least Square method of estimating one missing observation – RBD and LSD – Two observations missing in RBD and LSD – Analysis of covariance technique in CRD and RBD (without derivation).

**Unit-V** Factorial experiment – Definition – 22, 23 and 32 factorial experiments and their analysis – Principles of confounding – Partial and complete confounding in 23 – Split plot design and its analysis.

Recommended Text

* + - 1. Das, M.N. and Giri N.C (1979) : Design and Analysis of Experiments, Wiley Eastern, New Delhi.
			2. Gupta S.C. and Kapoor V.K (2007) : Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.

**Reference Books**

1. Kempthorne, (1956): Design and Analysis of Experiments, John Wiley, New York.
2. Montgomery . D. (1985): Design of Experiments, John Wiley and Sons.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

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| **SEMESTER: VI****PART: III****CORE: XIV** | **23USTAC62****DEMOGRAPHY** | **Credit:4****Hours :6** |

**Objectives of the Course** The main objectives of this course are:

1. Learn population and demographic registration
2. To learn fertility and mortality measurements
3. To understand Life table uses
4. To learn migration effect

Unit I Sources of demographic data – civil registration – population census registers – errors in demographic data – methods of improvements.

**Unit II** Fertility and mortality measurements – general and specific rates – standardized rates – age pyramid of sex composition gross and net reproduction rates.

**Unit III**  Life table – structure – construction – relationship between the function of a life table – abridged life table – population estimation – growth rates – gross and net reproduction rates component method of population projection – forces of mortality – Gompertz and Makeham’s law – logistic curve fitting and its use.

**Unit-IV** Spatial distribution of population –migration – kinds of migration – factors important in migration analysis – migration defining period and boundary – migration data by vital statistics and survival ratio and National Growth rate methods

**Unit-V** Components of population growth and change – Demographic transition theory – Methods of population projection – component method of projection, Leslie matrix, Logistic curve and its graduation

RECOMMENDED TEXT

1. Berclay, G.W.(1959) : Techniques of Population Analysis

2. Benjamin, B (1968) : Health and Vital Statistics, Allen &Unwin Srivastava,

3. O.S.(1983) : A text book of Demography , Vikas Publishing.

4. Bogue , Donald J: Principles of Demography (1976) John Willey, New York

**REFERENCE BOOKS**

1. Pathak. K.B. and Ram. F (1992): Techniques of Demography, Wiley Eastern.
2. Ram Kumar R (1986): Technical Demography, Wiley Eastern.

Website and

e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

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| **SEMESTER: VI****PART: III****CORE: XV** | **23USTAP63****PRACTICAL COVERING : CORE XIII & XIV**  | **Credit:4****Hours :6** |

**Practical Schedule:**

Analysis of variance – One way, Two way, classification (without interaction)

Completely Randomized Design (CRD) – Randomized block design (RBD) – RBD – More than one but equal number of observations per cell – Latin Square Design (LSD)

Least Square method of estimating one missing observation – RBD and LSD – Two observations missing in RBD and LSD – Analysis of covariance technique in CRD and RBD

22, 23 and 32 factorial experiments and their analysis – Partial and complete confounding in 23 – Split plot design

Mortality measurements - general and specific rates - standardized rates - age pyramid of sex composition - Ratios, propositions and percentage rates - Population pyramids, sex ratio, crude rate, specific rates, standard rates - direct and indirect.

Fertility, Measures of fertility, General fertility rate, Specific fertility rate, Net reproduction rate, Gross reproduction rate, Crude Rate of natural increase. stable population and stationery population calculations

Life table - Structure - Construction - Relationship between functions of the life table –

Population estimation and projection, component method of population projection Forces of mortality - Gompertz and Makcham law logistic curve fitting

**Text Books**

Books prescribed in the respective core papers shall be used

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| **SEMESTER: VI****PART: III****ELECTIVE: VII** | **23USTAE64****ACTUARIAL STATISTICS** | **Credit:3****Hours :5** |

**Objectives of the Course** The main objectives of this course are:

1. Itdevelopsagreaterunderstandingofstatisticalprinciplesandtheirapplicationinactuarial statistics.
2. Describethecoreareasofactuarialpracticeandrelatetothoseareasactuarialprinciples,theoriesandmodels.
3. It givestheunderstandingoftheapplicationknowledgeofthelifeinsuranceenvironment.

Unit I

 Simple and compound interest, present value and accumulated values of fixed rate, varying rate of interest

**Unit II**

Mortality: Gompertz- Makeham laws of mortality-life tables. Annuities:Endowments,Annuities,Accumulations,Assurances,Familyincomebenefits.

**Unit III**

Policy Values: Surrender values and paid up policies ,industrial assurances, Joint life and last survivor ship ,premiums.

**Unit IV**

Contingent Functions: Contingent probabilities, assurances. Decrement tables .Pension funds: Capital sums on Retirement and death, widow’s pensions, benefits dependent on marriage.

**Unit-V**

Principles of insurance, pure endowment, whole life assurance, Net premium for assurance and annuity plans-level annual premium under temporary assurance.

**RECOMMENDED TEXT**

1, Hooker,P.F., Longley, L.H.-Cook (1957) : Life and other contingencies, Cambridge.

2.. . . Alistair Neill(1977):Life contingencies, Heinemann professional publishing.

3. Gupta and Kapoor (2001) Fundamentals of Applied Statistics

**REFERENCE BOOKS**

Study material of IAI/IFoA of Actuarial Societies

Hosack,I.B.,Pollard,J.H.andZehnwirth,B.(1999):introductorystatisticswithapplicationsingeneralinsurance,Cambridge University.

Website and e-Learning Source e-books, tutorials on MOOC/SWAYAM courses on the subject

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| **SEMESTER: VI****PART: III****ELECTIVE: VIII** | **23USTAE65****TIME SERIES AND INDEX NUMBERS** | **Credit:3****Hours :5** |

**Objectives of the Course** The main objectives of this course are

**Course Objective(s)**

This course introduces the basic Statistical tools in time related Variables, economic variables. To enable the students understand index numbers and other Statistical tools applied to demographic and chorological data

**UNIT - I**

Time series - Concept - Components of time Series - Additive and multiplicative models - Measurement of trend - free hand method - semi average method - Moving average method - Least square method.

**UNIT - II**

Measurement of seasonal variations - Simple average method - Ratio to trend method - Ratio to moving average method - Link relative method - Variate Difference method.

**UNIT - III**

Index Numbers - uses - classification of index numbers - Problems in the construction of index numbers - Methods of constructing index numbers - Unweighted index numbers - weighted index numbers.

**UNIT - IV**

Quantity index numbers - Fixed and chain base index numbers - Optimum test for index numbers - Time reversal test - factor reversal test - cost of living index numbers.

**UNIT - V**

Demand Analysis Theory and analysis of consumer’s demand Law of demand, Price elasticity of demand estimation of demand curves forms of demand functions - Demand and Supply utility and indifference maps determination of price and supply and demand

**Text Books:**

1. Kapoor,V.K and Gupta,S.C (1978); Fundamentals of Applied Statistics, Sultan chand & Sons.

**Reference Books:**

1. Gupta, S.P (1999): Statistical Methods, Sultan & Sons, New Delhi.
2. Croxton, F.E & Cowdon, D.J. (1973): Applied general statistics, Prentice Hall
3. Mukhopadhyay P.(1999): Applied Statistics, New Central Book Agency Pvt. Ltd., Calcutta.

**Course Outcomes**

1. After studied unit - 1, the student will be able to know time series and its components

2. After studied unit - 2, the student will be able to know measuring seasonal variations in the data

3. After studied unit - 3, the student will be able to know index numbers and its usage

4. After studied unit - 4, the student will be able to know cost of living index and its applications

5. After studied unit - 5, the student will be able to know theory and applications of demand analysis

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| **SEMESTER: VI****PART: IV****Professional Competency Skill** | **23USTAF66****PYTHON PROGRAMMING:****DATA ANALYTICS WITH LATEST PACKAGES** | **Credit:2****Hours :2** |

**Objectives of the Course**  Upon completing this course, students will be able to:

1. Develop a regular workflow to execute reproducible research and analysis using Python programming.

2. Install and use Python language for specific application.

3. Import data from a variety of external sources

4. Write basic python functions using control and data structures

5. To know the basic concepts of Python.

**Course Outline**

**UNIT – I**

Introduction to python – Data types, Variables, Basic Input – Output Operations, Basic Operators

**UNIT – II**

Control statements, if statements, while loop, for loop, infinite loop, nested loop, else suit, break, continue, pass, assert, return statements, command line arguments.

**UNIT – III**

Arrays in python, advantages using arrays, creating arrays, importing the array module, indexing and slicing on arrays, Processing the arrays, Comparing arrays.

Strings in Python, Creating strings, Length of a string, Indexing in

strings, Slicing strings, Concatenation and Comparing Strings.

**Unit – IV**

Functions in Python, Define a function, Calling a function, return from function, pass by object reference, Positional arguments, Default arguments, excursive functions. Introduction to OOP, features of OOP, Creating classes, the self-variable, constructor, types of variables.

**Unit – V**

Inheritance: Define inheritance, types of inheritance, constructors in inheritance, overriding super class constructors & methods, the super() method.

Exceptions: Errors in a python program, Exceptions, Exception handling, Type of Exceptions, The Exception block, the assert

statement, user defined exceptions.

Skills acquired from this

Course Knowledge, Problem Solving, Analytical ability, Professional

Competency, Professional Communication and Transferrable Skill

**References Books**  1. Allen Downey, Jeffrey Elkner, Chris Meyers, How to think like a computer scientist: learning with Python, Freely available

online. 2012

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| **Website Links**  | Python Tutorial/Documentation www.python.or 2015 http://docs.python.org/3/tutorial/index.html http://interactivepython.org/courselib/statis/pythonds http://www.ibiblio.org/g2swap/byteofpython/read/  |

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| **SEMESTER: VI****PART: V** | **23USTAX67****EXTENSION ACTIVITY** | **Credit:1****Hours :-** |

**(Refer to the Regulations)**