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| B.Sc.,  Statistics |
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| **SYLLABUS** |
| **from the academic year**  **2023-2024** |
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| **TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005** |
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**B.Sc. Statistics : Programme Outcome, Programme Specific Outcome and Course Outcome**

Statistics is the study of Data and extracting knowledge in the data using various methods and techniques, analyze and interpret data, taking data driven predictions and decisions. It also helps data collection through sampling techniques, that is to collect data focusing on problem solving, and presenting it with wider scope of application in science, social sciences, medical science, life sciences, country’s official statistics etc. Statistical methods are used as research methodology in all most all domains. The key core areas of study in Statistics include Descriptive Statistics, Probability Theory, Sampling techniques, Matrix and Linear Algebra, Distribution Theory, Estimation Theory, Testing of Statistical hypotheses, Stochastic process, Regression analysis, Design of Experiments, Demography and Official Statistics. The Bachelor’s Degree B.Sc. Statistics is awarded to the students on the basis of knowledge, understanding, skills, attitudes, values and academic achievements expected to be acquired by learners at the end of the Programme. Learning outcomes of Statistics are aimed at facilitating the learners to acquire these attributes, keeping in view of their preferences and aspirations for gaining knowledge of Statistics.

Bachelor’s degree in Statistics is the culmination of in-depth knowledge in both theoretical and practical methods and techniques of Statistics. This also leads to study of related areas like Computer science, Industrial Statistics, Mathematical Statistics, Business Statistics and many more. Thus, this programme helps learners in building a solid foundation for higher studies in Statistics. The skills and knowledge gained have intrinsic aesthetics leading to proficiency in analytical reasoning. This can be utilized in Statistical modelling and solving real life problems.

Students completing this programme will be able to present Statistics clearly and precisely, make abstract ideas precise by formulating them in the language of Statistics, describe Statistical ideas from multiple perspectives and explain fundamental concepts of Statistics to those non-Statistics users.

Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs, entrepreneurship, business and research areas and jobs in various other public and private enterprises.

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| **LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME** | | |
| **Programme:** | **U.G.** | |
| **Programme Code:** |  | |
| **Duration:** | **3 years [UG]** | |
| **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**

**Highlights of the Revamped Curriculum**:

* Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
* The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising mathematical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced mathematical topics in the final semester, catering to the needs of stakeholders with research aptitude.
* The General Studies and Mathematics based problem solving skills are included as mandatory components in the ‘Training for Competitive Examinations’ course at the final semester, a first of its kind.
* The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
* The Industrial Statistics course is newly introduced in the fourth semester, to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
* The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
* Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
* State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest - Artificial Intelligence.

**Value additions in the Revamped Curriculum:**

|  |  |  |
| --- | --- | --- |
| **Semester** | **Newly introduced Components** | **Outcome / Benefits** |
| **I** | **Foundation Course**  To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning Literature and analysing the world through the literary lens  gives rise to a new perspective. | * Instill confidence among students * Create interest for the subject |
| **I, II, III, IV** | **Skill Enhancement papers** (Discipline centric / Generic / Entrepreneurial) | * Industry ready graduates * Skilled human resource * Students are equipped with essential skills to   make them employable |
| * Training on language and communication skills enable the students gain   knowledge and  exposure in the competitive world. |
| * Discipline centric skill will improve the Technical knowhow of solving real life   problems. |
| **III, IV, V & VI** | Elective papers | * Strengthening the domain knowledge * Introducing the stakeholders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature * Emerging topics in higher education/ industry/ communication network / health sector etc. are introduced with   hands-on-training. |

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| **IV** | Elective Papers | | * Exposure to industry moulds students into solution providers * Generates Industry ready graduates * Employment opportunities enhanced |
| **V Semester** | Elective papers | | * Self-learning is enhanced * Application of the concept to real situation is conceived resulting   in tangible outcome |
| **VI Semester** | Elective papers | | * Enriches the study beyond the course. * Developing a research framework and   presenting their  independent and  intellectual ideas effectively. |
| **Extra Credits:**  **For Advanced Learners / Honors degree** | | | * To cater to the needs of peer learners / research   aspirants |
| **Skills acquired from the Courses** | | Knowledge, Problem Solving, Analytical  ability, Professional Competency, Professional Communication and Transferrable Skill | |

**Credit Distribution for UG Programmes**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sem I** | **Credit** | **H** | **Sem II** | **Credit** | **H** | **Sem III** | **Credit** | **H** | **Sem IV** | **Credit** | **H** | **Sem V** | **Credit** | **H** | **Sem VI** | **Credit** | **H** |
| Part 1. Language – Tamil | 3 | 6 | Part..1. Language – Tamil | 3 | 6 | Part..1. Language – Tamil | 3 | 6 | Part..1. Language – Tamil | 3 | 6 | 5.1 Core Course –\CC IX | 4 | 5 | 6.1 Core Course –  CC XIII | 4 | 6 |
| Part.2 English | 3 | 6 | Part..2 English | 3 | 6 | Part..2 English | 3 | 6 | Part..2 English | 3 | 6 | 5.2 Core Course – CC X | 4 | 5 | 6.2 Core Course –  CC XIV | 4 | 6 |
| 1.3 Core Course – CC I | 5 | 5 | 2..3 Core Course – CC III | 5 | 5 | 3.3 Core Course – CC V | 5 | 5 | 4.3 Core Course – CC VII  Core Industry Module | 5 | 5 | 5. 3.Core Course CC -XI | 4 | 5 | 6.3 Core Course –  CC XV | 4 | 6 |
| 1.4 Core Course – CC II | 5 | 5 | 2.4 Core Course – CC IV | 5 | 5 | 3.4 Core Course – CC VI | 5 | 5 | 4.4 Core Course –  CC VIII | 5 | 5 | 5. 4.Core Course –/ Project with viva- voce  CC -XII | 4 | 5 | 6.4 Elective -VII Generic/ Discipline Specific | 3 | 5 |
| 1.5 Elective I Generic/ Discipline Specific | 3 | 4 | 2.5 Elective II Generic/ Discipline Specific | 3 | 4 | 3.5 Elective III Generic/ Discipline Specific | 3 | 4 | 4.5 Elective IV Generic/ Discipline Specific | 3 | 3 | 5.5 Elective V Generic/ Discipline Specific | 3 | 4 | 6.5 Elective VIII  Generic/ Discipline Specific | 3 | 5 |
| 1.6 Skill Enhancement Course SEC-1 | 2 | 2 | 2.6 Skill Enhancement Course SEC-2 | 2 | 2 | 3.6 Skill Enhancement Course SEC-4,  (Entrepreneurial Skill) | 1 | 1 | 4.6 Skill Enhancement Course SEC-6 | 2 | 2 | 5.6 Elective VI Generic/ Discipline Specific | 3 | 4 | 6.6 Extension Activity | 1 | - |
| 1.7 Skill Enhancement -(Foundation Course) | 2 | 2 | 2.7 Skill Enhancement Course –SEC-3 | 2 | 2 | 3.7 Skill Enhancement Course SEC-5 | 2 | 2 | 4.7 Skill Enhancement Course SEC-7 | 2 | 2 | 5.7 Value Education | 2 | 2 | 6.7 Professional Competency Skill | 2 | 2 |
|  |  |  |  |  |  | 3.8 E.V.S. | - | 1 | 4.8 E.V.S | 2 | 1 | 5.8 Summer Internship /Industrial Training | 2 |  |  |  |  |
|  | **23** | **30** |  | **23** | **30** |  | **22** | **30** |  | **25** | **30** |  | **26** | **30** |  | **21** | **30** |
| **Total – 140 Credits** | | | | | | | | | | | | | | | | | |

**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-1 | Language – Tamil | 3 | 6 |
| Part-2 | English | 3 | 6 |
| Part-3 | Core Courses & Elective Courses [in Total] | 13 | 14 |
| Part-4 | Skill Enhancement Course SEC-1 | 2 | 2 |
| Foundation Course | 2 | 2 |
|  |  | **23** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| Part-1 | Language – Tamil | 3 | 6 |
| Part-2 | English | 3 | 6 |
| Part-3 | Core Courses & Elective Courses including laboratory [in Total] | 13 | 14 |
| Part-4 | Skill Enhancement Course -SEC-2 | 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-1 | Language - Tamil | 3 | 6 |
| Part-2 | English | 3 | 6 |
| Part-3 | Core Courses & Elective Courses including laboratory [in Total] | 13 | 14 |
| Part-4 | 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-1 | Language - Tamil | 3 | 6 |
| Part-2 | English | 3 | 6 |
| Part-3 | Core Courses & Elective Courses including laboratory [in Total] | 13 | 13 |
| Part-4 | 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-3** | Core Courses including Project / Elective Based | 22 | 26 |
| **Part-4** | Value Education | 2 | 2 |
| Internship / Industrial Visit / Field Visit | 2 | 2 |
|  |  | **26** | **30** |

**Semester-VI**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credit** | **No. of Hours** |
| **Part-3** | Core Courses including Project / Elective Based & LAB | 18 | 28 |
| **Part-4** | Extension Activity | 1 | - |
| Professional Competency Skill | 2 | 2 |
|  |  | **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 | 1 | 22 |
| **Part V** | - | - | - | - | - | 2 | 2 |
| **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. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

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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 offbeat situations, Discussion, Debating or  Presentations | |

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| --- | --- | --- | --- |
| **Paper Type** | **Credit** | **Nos** | **Total** |
| Language | 3 | 8 | 24 |
| Core- Papers | 4 | 15 | 60 |
| Allied / Elective | 3 | 8 | 24 |
| Ability Enhancement Compulsory Course (AECC) Soft Skill- | 2 | 15 | 30 |
| Extension Activity | 1 | 2 | 2 |
| **Total** |  |  | 140 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Descriptive Statistics** | | | | | | | |
| **Paper Number** | | **CORE I** | | | | | | | |
| **Category** | Core | **Year** | I | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | | Basic arithmetic | | | | | | | |
| **Objectives of the Course** | | The main objectives of this 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. 4. Estimate and predict the unknown and future values. 5. Study of non-linear and consistency of the data. | | | | | | | |
| **Course Outline** | | **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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Gupta, S.P. (2017): Statistical Methods, Sultan Chand & Sons Pvt Ltd, New Delhi, 35th Revised Edition. 2. Gupta S.C and Kapoor, V.K. (2002). Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd., New Delhi | | | | | | | |
| Reference Books | | 1. Goon A.M. Gupta. A.K. and Das Gupta, B (1987). Fundamental of Statistics, vol.2 World Press Pvt. Ltd., Kolkatta 2. G.U.Yule and M.G. Kendall (1956). An introduction to the theory of Statistics, Charles Griffin. 3. M.R. Spiegel (1961). Theory and problems of Statistics, Schaum's outline series. 4. Anderson, T.W. and Sclove SL. (1978). An introduction to statistical analysis of data, Houghton Miffin&co. 5. Pillai, R.S., and Bagavathi (2003): Statistics, S. Chand and Company Ltd., New Delhi. | | | | | | | |
| Website and  e-Learning Source | | e-books, tutorials on MOOC/SWAYAM courses on the subject  <https://en.wikipedia.org/wiki/Statistics>  <https://en.wikipedia.org/wiki/Descriptive_statistics>  <https://socialresearchmethods.net/kb/statdesc.php>  <http://onlinestatbook.com/2/introduction/descriptive.html> | | | | | | | |

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

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 applyin data

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|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | M | S | M |
| **CLO2** | S | S | S | S | M | S | M | S | M |
| **CLO3** | S | S | S | M | S | S | M | S | S |
| **CLO4** | M | S | S | S | S | S | S | S | M |
| **CLO5** | S | S | S | S | M | S | S | S | M |
| **CLO6** | S | S | S | S | M | S | S | S | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Probability Theory** | | | | | | | |
| **Paper Number** | | **CORE II** | | | | | | | |
| **Category** | Core | **Year** | I | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **Er** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | | Basic Knowledge on events and set theory | | | | | | | |
| **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 | | | | | | | |
| **Course Outline** | | **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). | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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 andIdentify 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:**Aplication of probability theory in real life

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | M | S | M |
| **CLO2** | S | S | S | S | M | S | M | S | M |
| **CLO3** | S | S | S | M | S | S | M | S | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | S | M | S | S | S | M |
| **CLO6** | S | S | S | S | M | S | S | S | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Mathematics for Statistics** | | | | | | | |
| **Paper Number** | | **Elective I (Discipline Specific)** | | | | | | | |
| **Category** | Core | **Year** | I | | **Credits** | 3 | **Course Code** | |  |
| **Semest**  **Er** | I | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 3 | | 1 | | -- | | 4 | |
| **Pre-requisite** | | Calculus – Basic arithmetic | | | | | | | |
| **Objectives of the Course** | | 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. | | | | | | | |
| **Course Outline** | | **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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  Course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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 Outcome (for Mapping with POs and PSOs)

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

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | M | S | M |
| **CLO2** | S | S | S | S | M | S | M | S | M |
| **CLO3** | S | S | S | M | S | S | M | S | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | S | S | M |
| **CLO6** | S | S | S | S | M | S | S | M | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Matrix and Linear Algebra** | | | | | | | |
| **Paper Number** | | **Core III** | | | | | | | |
| **Category** | Core | **Year** | I | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | II | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | | Basic vector and matrix theory | | | | | | | |
| **Objectives of the Course** | | 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   3.To learn the invariance properties of ranks   1. To know and to apply the concepts of vector space and matrix polynomials. | | | | | | | |
| **Course Outline** | | **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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Vasishtha.A.R (1972)  :    Matrices, KrishnaprakashanMandir, 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 Outcome (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

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | M | S | M |
| **CLO2** | S | S | S | S | M | S | M | S | M |
| **CLO3** | S | S | S | M | S | M | M | S | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | S | S | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Distribution Theory** | | | | | | | |
| **Paper Number** | | **Core IV** | | | | | | | |
| **Category** | Core | **Year** | I | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | II | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | | Calculus | | | | | | | |
| **Objectives of the Course** | | 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 | | | | | | | |
| **Course Outline** | | 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). | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | M | S | M |
| **CLO2** | S | S | S | S | M | S | M | S | M |
| **CLO3** | S | S | S | M | S | M | M | S | M |
| **CLO4** | S | S | S | M | S | S | S | M | M |
| **CLO5** | S | M | M | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation betwee PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Real Analysis** | | | | | | | |
| **Paper Number** | | **Elective – II (Discipline specific)** | | | | | | | |
| **Category** | Core | **Year** | I | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | II | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | - | | -- | | 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 | | | | | | | |
| **Course Outline** | | Unit I              Operations on sets, Functions, Real valued functions, Equivalence, Countability, Real Numbers, Cantor set, Least Upper Bounds, Greatest Lower Bound. | | | | | | | |
| **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 | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  Course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Goldberg .R R(1976)   :    Methods of Real Analysis, Oxford &IBH. | | | | | | | |
| Reference Books | | 1. Shanthinarayan, ( 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/>  <http://www.ms.uky.edu/~droyster/courses/fall06/PDFs/Chapter06.pdf> | | | | | | | |

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

Students will be able to

**CLO-1** do basic operations of sets and understand set functions

**CLO-2** understand sequence and its convergence

**CLO-3** understand series and its convergence

**CLO-4** identify real valued functions and its discontinuity

**CLO-5** understand integration concepts

**CLO-6** understand probability functions as set functions and get knowledge on discrete and continuous nature of it

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | S | S | M |
| **CLO2** | S | S | S | S | M | S | S | S | M |
| **CLO3** | S | S | S | M | S | M | S | S | M |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Estimation Theory** | | | | | | | |
| **Paper Number** | | **Core - V** | | | | | | | |
| **Category** | Core | **Year** | II | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | III | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | | Number theory and Arithmetic | | | | | | | |
| **Objectives of the Course** | | The 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 | | | | | | | |
| **Course Outline** | | Unit I              Point estimation – Estimator – Consistency and Unbiasedness – 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 Minimax estimation – Simple illustrations. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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. 2. Goon A.M. Gupta M.K. and Das B. (1980): An Outline of Statistical Theory, Vol II, World Press, Calcutta 3. Sanjay Arora and Bansi Lal (1989) : New Mathematical Statistics, Satya Prakasam, New Delhi. 4. Hodges, J.L. and Lehman, E.L (1964): Basic Concepts of Probability and Statistics, Holden Day. 5. 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 | | | | | | | |

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

Students will be able to

**CLO-1** estimate population parameters

**CLO-2** identify good estimators and its properties

**CLO-3** derive interval estimators of a parameter

**CLO-4** estimate parameters using various estimation methods and identify the best among the estimators

**CLO-5** handle data and can estimate population parameters

**CLO-6** realize the application of different types of estimators

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | S | S | M |
| **CLO2** | S | S | S | S | M | S | S | S | M |
| **CLO3** | S | S | S | M | S | M | S | S | M |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Sampling Techniques** | | | | | | | |
| **Paper Number** | | **Core - VI** | | | | | | | |
| **Category** | Core | **Year** | II | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | III | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 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. | | | | | | | |
| **Course Outline** | | 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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Cochran, W.G. (1978) : Sampling Techniques, John Wiley Eastern 2. Murthy 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> | | | | | | | |

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

Students will be able to

**CLO-1** Know the difference between census and sampling.

**CLO-2** Understand basic operations and advantages of sampling

**CLO-3** Understand widely used sampling techniques

**CLO-4** Know to estimate population information using sampling

**CLO-5** Apply sampling techniques in real time problems

**CLO-6** identify suitable sampling technique for a real life survey

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | S | S | M |
| **CLO2** | S | S | S | S | M | S | S | S | M |
| **CLO3** | S | S | S | M | S | M | S | S | M |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Numerical Methods** | | | | | | | |
| **Paper Number** | | **Elective – III (Discipline Specific)** | | | | | | | |
| **Category** | Core | **Year** | II | | **Credits** | 3 | **Course Code** | |  |
| **Semest**  **er** | III | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | |  | | -- | | 4 | |
| **Pre-requisite** | | Basic Arithmetic and calculus | | | | | | | |
| **Objectives of the Course** | | 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 | | | | | | | |
| **Course Outline** | | 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) | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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. 5. 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 (for Mapping with POs and PSOs)

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

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | M | M | S | S | S | M |
| **CLO2** | S | S | S | S | M | S | S | S | M |
| **CLO3** | S | S | S | M | S | M | S | S | M |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Testing of Statistical Hypothesis** | | | | | | | |
| **Paper Number** | | **Core VII** | | | | | | | |
| **Category** | Core | **Year** | II | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | IV | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 3 | | 1 | | -- | | 4 | |
| **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 | | | | | | | |
| **Course Outline** | | 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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  Course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Robert V. Hogg and Allen T.Craig (1978), Introduction to Mathematical Statistics, 4th edition, Macmillan Publishing Co., Inc. New York 2. An Introduction to Probability and Statistics (2001), Rohatgi.V.K, and A.K.Md.EhsanesSaleh, John Wiley & Sons | | | | | | | |
| Reference Books | | 1. GuptaS.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. Graybill 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/> | | | | | | | |

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

Students will be able to

**CLO-1** frame hypotheses about population in real life research

**CLO-2** identify suitable testing procedure for given hypotheses

**CLO-3** compare two populations using samples taken from them

**CLO-4** Compare populations in its means and variances separately

**CLO-5** identify situations to apply parametric and nonparametric tests

**CLO-6** interpret results of a hypothesis testing

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | M | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | M | S | M | S | S | M |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Actuarial Statistics** | | | | | | | |
| **Paper Number** | | **Core VIII** | | | | | | | |
| **Category** | Core | **Year** | II | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | IV | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 3 | | 1 | | -- | | 4 | |
| **Pre-requisite** | | Basic arithmetic | | | | | | | |
| **Objectives of the Course** | | The main objectives of this course are:   1. It develops a greater understanding of statistical principles and their application in actuarial statistics. 2. Describe the core areas of actuarial practice and relate to those areas actuarial principles, theories and models. 3. It gives the understanding of the application knowledge of the life insurance environment. | | | | | | | |
| **Course Outline** | | Unit I Simple and compound interest, present value and accumulated values of fixed rate, varying rate of interest | | | | | | | |
| **Unit** Mortality : Gompertz - Makeham laws of mortality - life tables. Annuities: Endowments, Annuities, Accumulations, Assurances, Family income benefits. | | | | | | | |
| **Unit III**  Policy Values : Surrender values and paid up policies, industrial assurances, Joint life and last survivorship, 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 . | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / I AI I / IFoA thers to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  Course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1, 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 | | 1. Study material of IAI/IFoA of Actuarial Societies 2. Hosack,I.B., Pollard, J.H. and Zehnwirth, B.(1999) : introductory statistics with applications in general insurance, Cambridge University. | | | | | | | |
| 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

**CLO1** :To explain the utility theory and insurance terminologies.

**CLO2:** To articulate the insurance and annuity benefits through multiple life functions

evaluation for special mortality laws.

**CLO3**To describe the various types of premium and their numerical evaluations.

**CLO4**:To explain implementation of the Life insurance policies.

**CLO5**: To describe Insurance payable at the moment of death and at the end of the year

of death-level benefit insurance.

**CLO6:** To understand real life problems related to insurance

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | M | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | M | S | M | S | S | M |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | M | M | S | S | S | M |
| **CLO6** | S | M | M | S | M | S | S | S | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Economic & Official Statistics** | | | | | | | |
| **Paper Number** | | **Elective – IV** | | | | | | | |
| **Category** | Core | **Year** | II | | **Credits** | 3 | **Course Code** | |  |
| **Semest**  **Er** | IV | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 3 | | 1 | | -- | | 4 | |
| **Pre-requisite** | | Not needed | | | | | | | |
| **Objectives of the Course** | | The main objectives of this course are:   1. To understand Indian official statistical system and data collection 2. To know Indian economic and agricultural surveys 3. To know index numbers and consumer price index 4. To know time series analysis 5. To learn demand analysis and its concepts | | | | | | | |
| **Course Outline** | | Unit I  Indian Statistical System: Data Collection for Governance – NSSO and its role in national data collection. NSSO reports and publications | | | | | | | |
| **Unit II**  Economic Statistics: Information collection for Socio-Economic Survey – Agricultural, Industrial, Crime Statistics and Statistical methods applied to analyse large volumes of data | | | | | | | |
| **Unit III**  Index numbers: Basic problems in construction of index numbers. Methods- Simple and Weighted aggregate-Average of price relatives-Chain base method. Criteria of goodness-Unit test , Time Reversal Factor Reversal and Circular tests. Base Shifting, Splicing and deflating index numbers. Wholesale and Consumer price index numbers. Index of industrial production. | | | | | | | |
| **Unit-IV**  Time Series: Measurement of Trend : Graphic, Semi-averages, Moving averages. Least Squares – Straight line, Second degree parabola, Exponential curve, Modified Exponential curve, Gompertz curve and Logistic curve. Measurement of Seasonal variation by Ratio-to-Moving average method. Exponential smoothing , Holt Winter’s method and Box-Jenkinson’s method(only algorithm). | | | | | | | |
| **Unit-V** Demand Analysis: Introduction-Demand and Supply, Price elasticity of demand and supply, partial and cross elasticities of demand. Types of data required for estimating elasticity. Methods of estimating demand functions: Leontief ’s and Pigou’s methods. Engel’s law and Engel’s curves. Pareto’s law of law of income distribution. Utility function. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC IES-ISS/ TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  Course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Gupta S.C. and Kapoor V.K. (2007) :Fundamentals of Applied Statistics , 4th edition ,Sultan Chand &Sons Publishers, New Delhi. 2. Gupta S.P. (2011) :Statistical Methods , Sultan Chand &Sons Publishers, New Delhi. 3. Spyros Makridakis, Steven C. Wheelwright and Rob J .Hyndman ( 2003):Forecasting Methods and Applications , 3rd Edition ,John Wiley and Sons Inc. 4. Websites of Government of India – Ministry of Statistics & Programme Implementation | | | | | | | |
| Reference Books | | 1. Spyros Makridakis, Steven C. Wheelwright and Rob J .Hyndman (2003) :Forecasting Methods and Applications , 3rd Edition ,John Wiley and Sons Inc. . 2. Irving W. Burr (1974): Applied Statistical Methods, Academic Press. | | | | | | | |
| 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** :understand Indian official statistics and offices related to it

**CLO-2** understand Indian surveys for collecting official statistics

**CLO-3** know uses of index numbers

**CLO-4** know demand analysis and its need

**CLO-5** to understand economic India by knowing agricultural and economic surveys

**CLO-6** to know the time series and prediction

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | M | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | S | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | M | M | S | S | S | M |
| **CLO6** | S | S | M | S | M | S | S | S | M |

**CLO-PSO Mapping (Course Articulation Matrix) S-Strong, M-Medium, W-Weak**

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Stochastic Process** | | | | | | | |
| **Paper Number** | | **Core IX** | | | | | | | |
| **Category** | Core | **Year** | III | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | V | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | | Probability theory | | | | | | | |
| **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. | | | | | | | |
| **Course Outline** | | 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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Medhi, J. (2019): Stochastic Processes, New Age International Publishers. 2. KantiSwarup, Gupra.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 | | | | | | | |

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

Students will be able to

**CLO-1** Understand stochastic nature of random variable and different stochastic process

**CLO-2** know about transition matrix and its calculations

**CLO-3** understand Markov chain and its applications

**CLO-4** understand Markov process and its applications

**CLO-5** unserstand renewel process and its applications

**CLO-6** know about various stochastic modeling and its applications

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | M | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | M | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | M | M | S | M | S | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Regression Analysis** | | | | | | | |
| **Paper Number** | | **Core X** | | | | | | | |
| **Category** | Core | **Year** | III | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | V | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 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 | | | | | | | |
| **Course Outline** | | 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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, third edition, John Wiley and Sons, Inc. 2. Zar, J.H. (2006): Biostatistical Analysis, fourth edition, Pearson education. 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, McGraw Hill 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](http://home.iitk.ac.in/~shalab/regression/Chapter15-Regression-PoissonRegressionModels.pdf) | | | | | | | |

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

Students will be able to

**CLO-1** Estimating model parameters and testing it

**CLO-2** understand linear and nonlinear models assumptions

**CLO-3** check model adequacy

**CLO-4** know about variable selection

**CLO-5** know about nonlinear regression model**s**

**CLO-6** choose model if some of the basic assumptions are violated also

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | M | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | M | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | M | M | S | M | S | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Operations Research** | | | | | | | |
| **Paper Number** | | **Elective – V** | | | | | | | |
| **Category** | Core | **Year** | III | | **Credits** | 3 | **Course Code** | |  |
| **Semest**  **er** | V | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 3 | | 1 | | -- | | 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 | | | | | | | |
| **Course Outline** | | 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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. Kanti Swarup, P.K. Gupta and Manmohan (2007) Operations Research, Sultan Chand Sons, New Delhi. 2. S.D. Sharma (2002) : Operations Research: Kedarnath and Ramnath, Meerut. 3. 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 | | | | | | | |

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

Students will be able to

**CLO-1** understand optimization techniques and solving set of equations with constraints

**CLO-2** solve problems of linear programming

**CLO-3** understand transportation problems and its applications

**CLO-4** solve problems using games theory

**CLO-5** do replacement problems and solve it

**CLO-6** do network analysis and get problem solving skills

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | M | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | M | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | S | M | M | S | M | S | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Design of Experiments** | | | | | | | |
| **Paper Number** | | **Core XIII** | | | | | | | |
| **Category** | Core | **Year** | III | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | VI | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **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, factrorial and fractional factorial experiments, PIBD, inter and intra blocks, split plot, analysis covariance, Response surface methodology 3. To develop analytical thinking in problem solving skills | | | | | | | |
| **Course Outline** | | Unit I  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) abd uts abaktysus – 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. | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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 | | | | | | | |

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

Students will be able to

**CLO-1** To understand analysis of variance and experimental designs

**CLO-2** To have strong theoretical knowledge in Orthogonal latin squares, Hyper Graeco Latin squares

**CLO-3** Know factrorial and fractional factorial experiments, PIBD, inter and intra blocks, split plot, analysis covariance

**CLO-4** To understand clinical trial concepts and Response surface methodology

**CLO-5**To do numerical problems and able to get critical thinking to solve problems

**CLO-6** To choose suitable experiment and do it for real life problems

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | M | S | S | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | S | S |
| **CLO4** | S | S | S | M | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | M | S | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Demography** | | | | | | | |
| **Paper Number** | | **Core IV** | | | | | | | |
| **Category** | Core | **Year** | III | | **Credits** | 4 | **Course Code** | |  |
| **Semest**  **er** | VI | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | | 1 | | -- | | 5 | |
| **Pre-requisite** | |  | | | | | | | |
| **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 | | | | | | | |
| **Course Outline** | | 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 | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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 | | | | | | | |

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

Students will be able to

**CLO-1** to understand need of population study and its registration system

**CLO-2** to understand fertility and mortality effect on population

**CLO-3** to understand life table and its usage to real problems

**CLO-4** to get effect of migration in population

**CLO-5** to understand population growth and its effect

**CLO-6**: to understand the need of population study for a government

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | S | S | S | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | S | S |
| **CLO4** | S | S | S | S | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | M | M | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

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

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

**Level of Correlation between PSO’s and CO’s**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title of the Course** | | **Statistical Quality Control** | | | | | | | |
| **Paper Number** | | **Elective VII** | | | | | | | |
| **Category** | Core | **Year** | III | | **Credits** | 3 | **Course Code** | |  |
| **Semest**  **er** | VI | |
| **Instructional Hours**  **per week** | | **Lecture** | | **Tutorial** | | **Lab Practice** | | **Total** | |
| 4 | |  | | -- | | 4 | |
| **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. | | | | | | | |
| **Course Outline** | | 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 | | | | | | | |
| Extended Professional Component (is a part of internal component only, Not to be included in the External Examination  question paper) | | Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved  (To be discussed during the Tutorial hour) | | | | | | | |
| Skills acquired from this  course | | Knowledge, Problem Solving, Analytical ability, Professional  Competency, Professional Communication and Transferrable Skill | | | | | | | |
| Recommended Text | | 1. 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.   1. Grant, E,L. and Laven Worth, R.S.: Statistical Quality Control, McGraw Hill. | | | | | | | |
| 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** understand Industrial applications of Statistics

**CLO-2** understand statistical process control and methods for it

**CLO-3** understand attribute and variable control chart and interpret process based on it

**CLO-4**  understand the situations using special purpose controlcharts

**CLO-5** know various product control techniques

**CLO-6** To do numerical problems and able to get critical thinking to solve problems

To explore real life problems

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** | **PSO8** | **PSO9** |
| **CLO1** | S | S | S | S | S | S | S | S | S |
| **CLO2** | S | S | S | S | M | S | S | S | S |
| **CLO3** | S | S | S | S | S | M | S | S | S |
| **CLO4** | S | S | S | S | S | S | S | S | M |
| **CLO5** | S | S | M | M | M | S | M | M | M |
| **CLO6** | S | S | M | S | M | S | S | M | M |

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

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

**Level of Correlation between PSO’s and CO’s**

****