|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | 18MAB204T | **Course Name** | Probability and Queueing theory | **Course Category** | B | Basic Sciences | L | T | P | C |
| 3 | 1 | 0 | 4 |
|  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Pre- requisite**  **Courses** | 18MAB102T | | **Co-requisite Courses** | NIl | **Progressive Courses** | Nil |
| **Course Offering**  **Department** | | Mathematics | | **Data Book /**  **Codes/Standards** | Nil | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Course Learning Rationale (CLR):** | | *The purpose of learning this course is to:* | | | | **CLR-1 :** | *Apply and evaluating probability using random variables* | | | | | **CLR-2 :** | *Gain the knowledge and acquire the application of distribution to find the probability using Theoretical distributions* | | | | | **CLR-3 :** | *To Assess the appropriate model and apply and soling any realistic problem situation to determine the probability* | | | | | **CLR-4 :** | *To interpret the decision using Markov queueing applications* | |  |  | | **CLR-5 :** | *To construct chain of decisions from the past situations using Monrovians* | | | | | **CLR-6 :** | *Interpret random variables and Queuing theory in engineering problems.* | | | | | | | **Learning** | | |  | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| **Course Learning Outcomes (CLO):** | | *At the end of this course, learners will be able to:* |
| **CLO-1 :** | *Solving problems on Discrete and Continuous Random variables* | | *3* | *85* | *80* | *M* | *H* | *L* | *-* | *-* | *-* | *-* | *-* | *M* | *-* | *-* | *H* | *-* | *-* | *-* |
| **CLO-2 :** | *Identifying Distribution and solving the problems in Discrete and Continuous Distribution* | | *3* | *85* | *80* | *M* | *H* |  | *M* | *M* | *-* | *-* | *-* | *M* | *L* | *-* | *H* | *-* | *-* | *-* |
| **CLO-3 :** | *Decision Models using sampling techniques in Large and Small samples* | | *3* | *85* | *80* | *M* | *H* | *-* | *-* | *-* | *-* | *-* | *-* | *M* | *-* | *-* | *H* | *-* | *-* | *-* |
| **CLO-4 :** | *Solving Queuing problems using Kendall’s notation* | | *3* | *85* | *80* | *M* | *H* | *-* | *-* | *-* | *-* | *-* | *-* | *M* | *L* | *-* | *H* | *-* | *-* | *-* |
| **CLO-5 :** | *To Evaluate the probability in uncertain situations using Markov chain rule* | | *3* | *85* | *80* | *M* | *H* | *L* | *M* | *-* | *-* | *-* | *-* | *M* | *-* | *-* | *H* | *-* | *-* | *-* |
| **CLO-6 :** | *Solving and analyzing the problems in random variables and Queuing theory.* | | *3* | *85* | *80* | *M* | *H* | *-* | *-* | *-* | *-* | *-* | *-* | *M* | *-* | *-* | *H* | *-* | *-* | *-* |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Duration (hour)** | | **12** | **Learning Unit / Module 1** | **Proposed Date & Hour** | **Conducted Date & Hour** | **Remark** |
| **S-1** | SLO-1 | Probability Basic concepts and Axioms |  |  |  |
| SLO-2 | Conditional probability, Multiplication theorem |  |  |  |
| **S-2** | SLO-1 | Discrete and continuous Random variables |  |  |  |
| SLO-2 | Probability mass function, cdf |  |  |  |
| **S-3** | SLO-1 | Continuous Random variables |  |  |  |
| SLO-2 | pdf and cdf applications |  |  |  |
| **S-4** | SLO-1 | Problem solving using tutorial sheet 1 |  |  |  |
| SLO-2 |
| **S-5** | SLO-1 | Expectation and Variance |  |  |  |
| SLO-2 | Problems on Expectation and Variance |  |  |  |
| **S-6** | SLO-1 | Moment Generating Function |  |  |  |
| SLO-2 | Problems on MGF |  |  |  |
| **S-7** | SLO-1 | Functions of Random variables |  |  |  |
| SLO-2 | Problems on Functions of Random variable |  |  |  |
| **S-8** | SLO-1 | Problem solving using tutorial sheet 2 |  |  |  |
| SLO-2 |
| **S-9** | SLO-1 | Tchebycheffs inequality |  |  |  |
| SLO-2 | Introduction to theoretical distribution |  |  |  |
| **S-10** | SLO-1 | Formula and application of Tchebycheffs  Inequality |  |  |  |
| SLO-2 | Applications of chebychevs inequality |  |  |  |
| **S-11** | SLO-1 | Applications of chebychevs inequality using distribution |  |  |  |
| SLO-2 | Problems practice using chebychevs  Inequality |  |  |  |
| **S-12** | SLO-1 | Problem solving using tutorial sheet 3 |  |  |  |
| SLO-2 | Applications of random variables in engineering |  |  |  |
| **Duration (hour)** | **12** | **Learning Unit -II/ Module 2** | **Proposed Date & Hour** | **Conducted Date & Hour** | **Remark** |
| **S-1** | SLO-1 | Discrete Probability distribution |  |  |  |
| SLO-2 | Introduction to Binomial distribution |  |  |  |
| **S-2** | SLO-1 | MGF, Mean, Variance of Binomial  Distribution |  |  |  |
| SLO-2 | Applications of Binomial distribution |  |  |  |
| **S-3** | SLO-1 | Fit a Binomial distribution. |  |  |  |
| SLO-2 | Introduction to Poisson Distribution |  |  |  |
| **S-4** | SLO-1 | Problem solving using tutorial sheet 4 |  |  |  |
| SLO-2 |
| **S-5** | SLO-1 | MGF , Mean , Variance of  Poisson distribution |  |  |  |
| SLO-2 | Applications of Poisson Distribution |  |  |  |
| **S-6** | SLO-1 | Fit a Poisson Distribution |  |  |  |
| SLO-2 | Introduction , MGF Mean, Variance of  Geometric distribution |  |  |  |
| **S-7** | SLO-1 | Applications of Geometric Distribution,  problems on Memory less property |  |  |  |
| SLO-2 | Introduction , MGF, Mean, Variance of  Uniform Distribution |  |  |  |
| **S-8** | SLO-1 | Problem solving using tutorial sheet 5 |  |  |  |
| SLO-2 |
| **S-9** | SLO-1 | Applications of Uniform Distribution problems |  |  |  |
| SLO-2 | Introduction , MGF, Mean, Variance of  Exponential distribution |  |  |  |
| **S-10** | SLO-1 | Applications of Exponential distribution  Problems |  |  |  |
| SLO-2 | Introduction to Normal distribution |  |  |  |
| **S-11** | SLO-1 | Applications of Normal distribution problems |  |  |  |
| SLO-2 | Practical applications of Normal distribution |  |  |  |
| **S-12** | SLO-1 | Problem solving using tutorial sheet 6 |  |  |  |
| SLO-2 | Applications of distribution to find the probability using Theoretical distributions |  |  |  |
| **Duration (hour)** | **12** | **Learning Unit -III/ Module 3** | **Proposed Date & Hour** | **Conducted Date & Hour** | **Remark** |
| **S-1** | SLO-1 | Sampling distribution, Null Hypothesis,  Alternate Hypothesis |  |  |  |
| SLO-2 | One tailed test, two tailed test |  |  |  |
| **S-2** | SLO-1 | Level of significance, Critical region |  |  |  |
| SLO-2 | Large samples test |  |  |  |
| **S-3** | SLO-1 | Student - t test - Single Proportion |  |  |  |
| SLO-2 | Two Sample proportions |  |  |  |
| **S-4** | SLO-1 | Problem solving using tutorial sheet 7 |  |  |  |
| SLO-2 |
| **S-5** | SLO-1 | Large sample test- Single Mean |  |  |  |
| SLO-2 | Difference of Means |  |  |  |
| **S-6** | SLO-1 | Problems on difference of Means |  |  |  |
| SLO-2 | Applications of Difference of Means |  |  |  |
| **S-7** | SLO-1 | Introduction to small samples |  |  |  |
| SLO-2 | Introduction to small Samples |  |  |  |
| **S-8** | SLO-1 | Problem solving using tutorial sheet 8 |  |  |  |
| SLO-2 |
| **S-9** | SLO-1 | Problems on single mean -small samples |  |  |  |
| SLO-2 | Problems on single mean -small samples |  |  |  |
| **S-10** | SLO-1 | Problems on difference of mean-small  Samples |  |  |  |
| SLO-2 | Problems on difference of mean-small  Samples |  |  |  |
| **S-11** | SLO-1 | Applications of paired - t test |  |  |  |
| SLO-2 | Problems of paired - t test. |  |  |  |
| **S-12** | SLO-1 | Problem solving using tutorial sheet 9 |  |  |  |
| SLO-2 | Applications of solving any realistic problem situation to determine the Probability |
| **Duration (hour)** | **12** | **Learning Unit -IV/ Module 4** | **Proposed Date & Hour** | **Conducted Date & Hour** | **Remark** | **12** | **Learning Unit -IV/ Module 4** | **Proposed Date & Hour** | **Conducted Date & Hour** |
| **S-1** | SLO-1 | Introduction to F-test |  |  |  |
| SLO-2 | Problems on F-test |  |  |  |
| **S-2** | SLO-1 | Chi square test -Goodness of fit |  |  |  |
| SLO- 2 | Problems on Chi square test -Goodness of fit |  |  |  |
| **S-3** | SLO-1 | Problems on Chi-square test Independent-  Attributes |  |  |  |
| SLO- 2 | Problems on Chi-square test Independent-  Attributes with standard distributions |  |  |  |
| **S-4** | SLO-1 | Problem solving using tutorial sheet 10 |  |  |  |
| SLO- 2 |  |
| **S-5** | SLO-1 | Introduction to Queueing Theory and  Applications. Kendall, notation |  |  |  |
| SLO-2 | Introduction to M/M/1 : infinity/ FIFO |  |  |  |
| **S-6** | SLO-1 | Ls, Lq, Ws,Wq |  |  |  |
| SLO- 2 | M/M/1 :Infinity /FIFO problems |  |  |  |
| **S-7** | SLO-1 | M/M/1 :Infinity /FIFO problems |  |  |  |
| SLO- 2 | M/M/1 :Infinity /FIFO problems |  |  |  |
| **S-8** | SLO-1 | Problem solving using tutorial sheet 11 |  |  |  |
| SLO- 2 |  |
| **S-9** | SLO-1 | Single Server Model with Finite System Capacity, Characteristics of the Model  (M/M/1) : (K/FIFO) |  |  |  |
| SLO- 2 | Effective arrival rate |  |  |  |
| **S-10** | SLO-1 | Problems on Model (M/M/1) : (K/FIFO) |  |  |  |
| SLO- 2 | Problems on Model (M/M/1) : (K/FIFO) |  |  |  |
| **S-11** | SLO-1 | Problems on Model (M/M/1) : (K/FIFO) |  |  |  |
| SLO- 2 | Problems on Model (M/M/1) : (K/FIFO) |  |  |  |
| **S-12** | SLO-1 | Problem solving using tutorial sheet 12 |  |  |  |
| SLO- 2 | Applications of Queueing decision models |  |  |  |
| **Duration (hour)** | **12** | **Learning Unit -V/ Module 5** | **Proposed Date & Hour** | **Conducted Date & Hour** | **Remark** |
| **S-1** | SLO-1 | Markov Process and Introduction of a  Markov Chain |  |  |  |
| SLO-2 | Past and Future - Step and State |  |  |  |
| **S-2** | SLO-1 | One step Transition Probability  N step transition Probability |  |  |  |
| SLO- 2 | Chapman-kolmogorov theorem definition |  |  |  |
| **S-3** | SLO-1 | Initial Probability distribution problems  Using Markov Chain |  |  |  |
| SLO- 2 | Initial Probability distribution problems  Using Markov Chain |  |  |  |
| **S-4** | SLO-1 | Problem solving using tutorial sheet 13 |  |  |  |
| SLO- 2 |  |
| **S-5** | SLO-1 | Classification of States of a Markov Chain |  |  |  |
| SLO-2 | Irreducible, Non irreducible, a period, Persistent, Non null Persistent |  |  |  |
| **S-6** | SLO-1 | Problems on Classification of a Markov  Chain |  |  |  |
| SLO- 2 | Problem on Classification of a Markov  Chain |  |  |  |
| **S-7** | SLO-1 | Classification of states of a Markov Chain |  |  |  |
| SLO- 2 | Stationary and steady state |  |  |  |
| **S-8** | SLO-1 | Problem solving using tutorial sheet 14 |  |  |  |
| SLO- 2 |
| **S-9** | SLO-1 | Problems on Classification-State-stationary using Markov Chain |  |  |  |
| SLO-2 | Problems on Stationary and steady state |  |  |  |
| **S-10** | SLO-1 | Problems on Ergodicity using Markov  Chain |  |  |  |
| SLO- 2 | Problems on Ergodicity using Markov  Chain |  |  |  |
| **S-11** | SLO-1 | Problems on Ergodicity |  |  |  |
| SLO- 2 | Problems on Ergodic and Non Ergodic  Using Markovchains |  |  |  |
| **S-12** | SLO-1 | Problem solving using tutorial sheet 15 |  |  |  |
| SLO- 2 | Applications of constructing chain of decisions from the past situations using Monrovians |  |  |  |

|  |  |  |
| --- | --- | --- |
| **Learning Resources** | 1. *Veerarajan T, Probability , Statistics and Random Processes, Tata Mc.Graw Hill, 1st Reprint 2004* 2. *S.C. Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, 9th ed.,, Sultan Chand & Sons, 1999* 3. *Gross. D and Harri.C.M. Fundamentals of Queuing theory, John Wiley and Sons, 1985* | 1. *Trivedi K S, Probability and Statistics with reliability, Queueing and Computer Science Applications, prentice Hall of India, New Delhi, 1984* 2. *Allen .A.O. , Probability Statistics and Queueing theory, Academic Press* |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Learning Assessment** | | | | | | | | | | | |
|  | Bloom’s Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage)  CLA – 1 (10%) | |
| CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | |
| Theory | Practice |  |  | Theory | Practice |  |  | Theory | Practice |
| Level 1 | Remember | *40 %* | *-* | Level 1 | Remember  Understand | *40 %* | *-* | Level 1 | Remember  Understand | *40 %* | *-* |
| Understand |
| Level 2 | Apply | *40 %* | *-* | Level 2 | Apply  Analyze | *40 %* | *-* | Level 2 | Apply  Analyze | *40 %* | *-* |
| Analyze |
| Level 3 | Evaluate | *20 %* | *-* | Level 3 | Evaluate  Create | *20 %* | *-* | Level 3 | Evaluate  Create | *20 %* | *-* |
| Create |
|  | Total | 100 % | | 100  % | |  | | Total | | 100 % | |

|  |  |  |
| --- | --- | --- |
| **Course Designers** | | |
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| 1. Mr. V. Maheshwaran, CTS, Chennai,   [maheshwaranv@yahoo.com](mailto:maheshwaranv@yahoo.com) | 1. Dr. K. C. Sivakumar, IIT, Madras, [kcskumar@iitm.ac.in](mailto:kcskumar@iitm.ac.in) | 1. Dr. A. Govindarajan, SRMIST |
| 2. Dr. Sricharan Srinivasan, Wipro Technologies, [sricharanms@gmail.com](mailto:sricharanms@gmail.com) | 2. Dr. Nanjundan, Bangalore  University, [nanzundan@gmail.com](mailto:nanzundan@gmail.com) | 2. Dr. V. Srinivasan, SRMIST |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Prepared By HOD/MATHEMATICS