| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| MA0M30A | RANDOM PROCESS AND QUEUEING THEORY | BTECH MINOR S5 | 3 | 1 | 0 | 4 | 2020 |

## i) COURSE OVERVIEW:

**ii)** This course introduces learners to the applications of probability theory in the modelling and analysis of stochastic systems, covering important models of random processes such as Poisson Process, Markov chain and queueing systems. The tools and models introduced here have important applications in engineering and are indispensable tools in signal analysis, reliability theory, network queues and decision analysis

## iii)COURSE OUTCOMES

After the completion of the course, the student will be able to:

| Course Outcomes | Description | Learning Level |
|---|---|---|
| CO 1 | Characterize phenomena which evolve probabilistically in time using the tools autocorrelation and power spectrum | Understand |
| CO 2 | Characterize stationary processes using ergodic property and analyse processes using poisson model wherever appropriate | Apply |
| CO 3 | Model and analyze random phenomena using discrete time Markov chains | Apply |
| CO 4 | Explain basic characteristic features of a queuing system and analyse queuing models | Apply |
| CO 5 | Analyse complex queueing systems by applying basic principles of queueing theory | Apply |

## iv) SYLLABUS

Module 1 (Random processes and stationarity) Random processes-definition and classification, mean, autocorrelation, stationarity-strict sense and wide sense, properties of autocorrelation function of WSS processes. Power spectral density of WSS processes and its properties- relation to autocorrelation function. White noise. Module 2 (Poisson processes) Ergodic processes-ergodic in the mean and autocorrelation. Mean ergodic theorems (without proof). Poisson processes-definition based on independent increments and stationarity, distribution of inter-arrival times, sum of independent Poisson processes, splitting of Poisson processes. Module 3 (Markov chains) Discrete time Markov chain -Transition probability matrix, Chapman Kolmogorov theorem (without proof), computation of probability distribution, steady state probabilities. Classification of states of finite state chains , irreducible and ergodic chains. Module 4 (Queueing theory-I) Queueing systems, Little’s formula (without proof), Steady state probabilities for Poisson queue systems, M/M/1 queues with infinite capacity and finite capacity and their characteristics-expected number of customers in queue and system, average waiting time of a customer in the queue and system Module 5 (Queueing theory-II) Multiple server queue models, M/M/s queues with infinite capacity, M/M/s queues with finite capacity-in all cases steady state distributions and system characteristics-expected number of customers in queue and system, average waiting time of a customer in the queue and system

## v) TEXT BOOKS

1. Alberto leon Garciai, Probability and random processes for electrical engineering, Pearson Education, Second edition

2. V Sundarapandian, Probability statistics and queueing theory, Prentice-Hall Of India

## (v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| I | Random-process, classification, Mean, variance, autocorrelation, autocovariance Strict sense stationary processes WSS processes Properties of autocorrelation of a WSS process Power spectral density, relation to autocorrelation Delta function, white noise | 12 |
| II | Ergodic property, definition, examples Mean ergodic theorems and applications Poisson process-independent increments, stationarity Mean, variance, autocorrelation, autocovariance of Poisson process Distribution of inter-arrival times Splitting (thinning) of Poisson processes Merging of Poisson process | 12 |
| III | Discrete time Markov chain-memory lessness, examplesition probability matrix, Chapman-Kolmogorov Transition probabilities and transition matrices Chapman-Kolmogorov theorem and applications Computation of transient probabilities Computation of transient probabilities classification of states of finite-state chains, irreducible and ergodic chains Steady state probability distribution of ergodic chains | 12 |
| IV | Basic elements of Queueing systems, Little's formula, Steady state probabilities for Poisson queue systems M/M/1 queues with infinite capacity, steady state probabilities M/M/1 queues with infinite capacity-computating system characteristics M/M/1 queues with finite capacity, steady state probabilities M/M/1 queues with finite capacity- computating system characteristics | 12 |
| V | Basic elements of multiple server queues M/M/s queues with infinite capacity, steady state probabilities M/M/s queues with infinite capacity-computing system characteristics M/M/s queues with finite capacity, steady state probabilities M/M/s queues with finite capacity- computing system characteristics | 12 |
| | Total hours | 60 |

## i) ASSESSMENT PATTERN

| Bloom's Taxonomy Level | Continuous Assessment Exams (Marks) | | End Semester Exam (Marks) |
|---|---|---|---|
| | **CA Exam I** | **CA Exam II** | |
| Remember | 10 | 10 | 20 |
| Understand | 20 | 20 | 40 |
| Apply | 20 | 20 | 40 |
| Analyse | | | |
| Evaluate | | | |
| Create | | | |

## ii) CONTINOUS ASSESSMENT EVALUATION PATTERN

| | | |
|---|---|---|
| Attendance | : | **10 marks** |
| CA Exams (2 numbers) | : | **25 marks** |
| Assignment/Project/Case study etc. | : | **15 marks** |
| **Total** | : | **50 marks** |

## iii) CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **Two tests of 50 marks** each (half the syllabus to be covered in each exam – 2 ½ modules)
- Duration – **2 hours**

## iv) END SEMESTER EXAMINATION PATTERN

Duration – **3 hours**

Total marks -**100**