Discipline Specific Core (DSE) Course 3d: Stochastic Models

Structure 1: PG Curricular Structure with only Course Work
Structure 2: PG Curricular Structure with Course Work + Research
Structure 3: PG Curricular Structure with Research only

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the course (if any)
		Lecture (45 Hours)	Tutorial (15 Hours)	Practical (00 Hours)		
DSE 3d: Stochastic Models	4	3	1	0	NIL	Basic knowledge of Probability

Course Objectives:

- To introduce fundamental principles of stochastic queueing and reliability models with intent.
- To evaluate and improve the efficiency of systems and its components related to various fields like engineering, manufacturing, and technology.

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

- Handle situations involving more than one random variable.
- Analyse the performance of reliability models.
- Model real life stochastic queueing situations.
- Analyse a network of queues with Poisson arrivals having general and exponential service requirements.
- Understand the concept of Maintainability and Availability in reliability modelling.
- Understand the use of statistical methods to evaluate and improve the reliability of systems in various fields like engineering, manufacturing etc.

Unit I (10 Hours)

Review of Stochastic processes: Markov process, Markov chain, Poisson Process, Birth and Death process. Stochastic queueing models: General concepts, Stationary distribution of Markovian queueing models with state dependent service, bulk arrivals and impatience.

Unit II (11 Hours)

Transient solution of birth and death exponential queueing models: M/M/1 and M/M/∞ with their measures of effectiveness including busy period distribution. Imbedded Markov chain technique and its use to solve the M/G/1 queueing models. Measures of effectiveness of M/G/1 queueing model.

Unit III (12 Hours)

Concept of reliability, Failures, failure modes: early age failures, wear out failures and chance failures and their representation with bathtub curve, Derivation of general reliability function, failure density function and mean time to failure (MTTF), Time dependent Hazard models, constant hazard models, linear hazard models, nonlinear hazard models. Derivation of two state reliability models using the Markov process.

Unit IV: (12 Hours)

Stochastic Reliability Models: Reliability of the multi-component stochastic System models, Maintainability and Availability: Concept of Maintainability, Maintainability function, Preventive maintenance, mean time between failure (MTBF), Availability, availability function, Derivation of availability function for: single component system with repair, two-unit parallel system with repair using Markov process.

Tutorial:

Tutorial sessions will include at least one activity such as group discussion/presentation/ problem solving exercise based on the material covered in the lectures along with scholastic work related to the conceptual understanding of the subject.

Essential Readings:

1. Balagurusamy, E. (2017). *Reliability Engineering,* McGraw Hill Publications.
2. Billinton, R. and Allan, R.N. (2013). *Reliability evaluation of engineering systems: Concepts and techniques,* Springer.
3. Gross, D. and Harris C.M. (2008). *Fundamentals of Queueing Theory,* John Wiley & Sons.
4. Satty, T. L. (1983). *Elements of Queuing Theory with Applications,* Dover Publications.

Suggested Readings:

1. Bazovsky, I. (2013). *Reliability Theory and Practice*, Dover Publications.
2. Cooper, R.B. (1981). *Introduction to Queuing Theory,* North Holland, Elsevier.

3. Cox, D.R., and Miller, H.D. (1972). *The theory of stochastic processes*, Chapman and Hall.
4. Lewis, E. E. (1996). *Introduction to Reliability Engineering*, John Wiley & Sons.
5. Medhi, J. (2022). *Stochastic processes*, New Age International Publications.
6. Meeker, W.Q. and Escobar, L.A. (1998). *Statistical Methods for Reliability Data*, John Wiley & Sons.