

Preface

Nothing lasts forever and so is the life of engineering systems. The consequence of failures of engineering system ranges from minor inconvenience to significant economic loss and deaths. Designers, manufacturers, and end users strive to minimize the occurrence and recurrence of failures. In order to minimize failures in engineering systems, it is essential to understand ‘why’ and ‘how’ failures occur. It is also important to know how often such failures may occur. If failures occur, inherent safety systems/measures must ensure the consequences of failures are minimal. Reliability deals with the failure concept, whereas safety deals with the consequences of failure. Reliability and Safety Engineering explores failures and consequences of failures to improve the performance of engineering systems. It plays a vital role in sectors such as chemical and process plants, nuclear facilities, and aerospace which can impose potential hazards. The main benefit of its application is to provide insights into design, performance, and environmental impacts, including the identification of dominant risk contributors and the comparison of options for reducing risk. In addition, it provides inputs to decisions on design and back fitting, system operation and maintenance, safety analysis and on regulatory issues.

Reliability and safety are the core issues to be addressed during the design, operation, and maintenance of engineering systems. LCC and sustainability are key to the understanding of risk and environmental impact of operation and maintenance of systems over the designed life leading to what one may call the ‘Green Reliability’. This book aims to present basic concepts and applications along with latest state of art methods in Reliability and Safety engineering. The book is organized as follows:

Chapter 1 introduces reliability and safety concepts and discusses basic terminology, resources, past, present challenges, and future needs. Chapter 2 provides a detailed review of probability and statistics essential for understanding the reliability and safety analysis methods discussed in the remaining chapters.

Chapter 3 discusses various system reliability modeling techniques such as Reliability Block Diagram, Fault Tree Analysis, and Markov modeling. Component (or basic event) reliability values are assumed to be available in analyzing system

level reliability. Repairable systems are also addressed and several practical examples are given. In Chap. 4, methods that focus on reliability analysis of complex systems, Monte Carlo simulation, and dynamic fault tree analysis are explained.

Conventional engineering fields, viz., Electronics Engineering, Software Engineering, Mechanical Engineering, and Structural Engineering, have their own terminology and methodologies in applying the reliability concepts. Though the basic objective is to improve the system effectiveness, approach in adopting reliability concepts is slightly case specific to each area. Chapters 5–8 present reliability terminology in the various above-mentioned conventional engineering fields. The current practices, resources, and areas of research are highlighted with respect to each field.

Chapter 9 focuses on maintenance of large engineering systems. Essentially this chapter covers two areas of maintenance, i.e., prioritizing of equipment and optimization in maintenance decision making.

Methodology for Probabilistic Safety Assessment (PSA) in general is addressed in Chap. 10. Various elements of PSA including common cause failure analysis, human reliability analysis, and importance measures are presented. Chapter 11 introduces dynamic methods in safety analysis with special emphasis on dynamic event tree analysis; the elements involved in the method and comparison among its implementation are also discussed. Practical applications of PSA in operation and maintenance activities of complex systems like nuclear power plants are discussed in Chap. 12.

Uncertainty is present in any reliability and safety calculation due to limitations in exactly assessing the parameters of the model. Creditability and practical usability of reliability and risk analysis results is enhanced by appropriate treatment of uncertainties. Various uncertainty propagation and analyzing methods including Monte Carlo simulation, Fuzzy arithmetic, Probability Bounds, and Dempster-Shafer theory are explained in Chaps. 13 and 14.

This book is useful for advanced undergraduate and postgraduate students in Nuclear Engineering, Aerospace Engineering, Industrial Engineering, Reliability and Safety Engineering, Systems Engineering, Applied Probability and Statistics, and Operations Research. The book is also suitable for one semester graduate course on Reliability and Safety Engineering in all conventional engineering branches like Civil, Mechanical, Chemical, Electrical, Electronics, and Computer Science. It will also be a valuable reference for practicing engineers, managers, and researchers involved in reliability and safety activities of complex engineering systems.

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