

Preface

Reliability is an important and challenging subject, which involves the disciplines of science and engineering. Researchers in both these fields have been working on reliability problems for several decades. The aim of this book is to summarize various ageing and dependence concepts of the lifetimes that have been widely studied in the field of reliability.

Chapter 1 provides a summary of the book and notations and acronyms are also listed for easy reference later on. Chapter 2 deals with various concepts of stochastic ageing starting with the definition of the failure rate function (or hazard function). In this book, we will use the term failure rate instead of hazard rate, which is more common in survival analysis. Part of the reason is because most abbreviations such as IFR/DFR/IFRA/DFRA, etc., contain FR which stands for failure rate. We think that more confusion will be caused if the abbreviations are changed. Moreover, the acronym ‘failure rate’ is more commonly used in reliability engineering, especially for non-repairable systems.

Chapters 3–7 deal with some specific concepts of ageing and lifetime distributions. In particular, we consider bathtub shaped life distributions in Chapter 3. Existing models are grouped and summarized with their properties listed. Chapter 4 considers the mean residual lifetime function which is an important measure of ageing in reliability applications. Chapter 5 deals with the Weibull distribution and its generalizations that can be flexible in modeling lifetime data. Chapter 6 considers ageing concepts for discrete distributions. Chapter 7 summarizes statistical tests of ageing.

Chapter 8 extends the univariate ageing concepts to two or more variables. A brief introduction to the Bayesian approach to multivariate ageing in terms of majorization and Schur-concavity is given.

Dependence concepts, dependence orderings and measures of dependence are dealt with in Chapter 9. This is an extensive and important topic which caught the attention of many authors in recent years. We emphasize the positive (negative) quadrant dependence as this property is verifiable and realistic in many situations. All relevant results concerning dependence are summarized in this chapter. However, most of these results are related to statistical concepts and some are theoretical probability applications. We expect further research and applications in this area to be carried out by researchers. As a follow-up, Chapter 10 discusses the reliability of coherent systems with positively dependent components. We feel that this topic is a very important one in reliability applications.

Last but not least, in Chapter 11, we list 33 data sets of failure times or survival times. This could be useful for researchers and students in their future study in this field. The book ends with a large collection of references with nearly eight hundred entries.

It is our aim to provide a comprehensive treatment of both ageing and dependence concepts with emphasis on reliability and survival analysis. Proofs

of many results are omitted, especially when they are either obvious or are long. The interested readers may refer to references listed in the bibliography section for detailed proofs. The readers should, however, have some basic knowledge in probability and statistics before reading this book.

Apart from the excellent classical text by Barlow and Proschan (1981), Gertsbach (1989) is another good book on statistical reliability. There is an excellent book on ageing, written from a Bayesian point of view, by Spizzichino (2001). Also on dependence concepts and stochastic ageing, there is an excellent book by Shaked and Shanthikumar (1994). On multivariate dependence concepts, Joe (1997) has provided us an excellent monograph.

We hope that both reliability researchers and practitioners find the book useful for reference and for some new ideas. This book will also be useful for graduate students in reliability or applied probability.

This book is a summary of the work carried out by many people. It would be too long a list if we acknowledge them one by one – most of the names can be found in the reference list at the end of the book. We wish to thank, in particular, Mr. John Kimmel of Springer who had guided us through the whole project with much encouragement and professionalism. We also wish to record our our sincere thanks to several anonymous reviewers for their constructive comments. We appreciate very much the help from all of them, and other colleagues and students of us.

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