

Preface

The development of queueing theory dates back more than a century. Originally the concept was examined for the purpose of maximizing performance of telephone operation centers; however, it was realized soon enough that issues in that field that were solvable using mathematical models might arise in other areas of everyday life as well. Mathematical models, which serve to describe certain phenomena, quite often correspond with each other, regardless of the specific field for which they were originally developed, be that telephone operation centers, planning and management of emergency medical services, description of computer operation, banking services, transportation systems, or other areas. The common feature in these areas is that demands and services occur (also at an abstract level) with various contents depending on the given questions. In the course of modeling, irrespective of the meaning of demand and service in the modeled system, one is dealing with only moments and time intervals. Thus it can be concluded that, despite the diversity of problems, a common theoretical background and a mathematical toolkit can be relied upon that ensures the effective and multiple application of a theory. It is worth noting as an interesting aspect that the beginning of the development of queueing theory is closely connected to the appearance of telephone operation centers more than a century ago, as described previously; nevertheless, it still plays a significant role in the planning, modeling, and analyzing of telecommunication networks supplemented by up-to-date simulation methods and procedures.

The authors of this book have been conducting research and modeling in the theoretical and practical field of queueing theory for several decades and teaching in both bachelor's, master's, and doctoral programs in the Faculty of Informatics, Eötvös Loránd University, Faculty of Engineering Sciences, Széchenyi István University, John von Neuman Faculty of Informatics, Óbuda University and the Faculty of Electrical Engineering and Informatics, Budapest University of Technology and Economics (all located in Hungary).

The various scientific backgrounds of the authors complement each other; therefore, both mathematical and engineering approaches are reflected in this book. The writing of this book was partly triggered by requests from undergraduate and Ph.D. students and by the suggestions of supportive colleagues, all of whom expressed the

necessity to write a book that could be directly applied to informatics, mathematics, and applied mathematics education as well as other fields. In considering the structure of the book, the authors tried to briefly summarize the necessary theoretical basis of probability theory and stochastic processes, which provide a uniform system of symbols and conventions to study and master the material presented here. At the end of Part I, the book provides a systematic and detailed treatment of Markov chains, renewal and regenerative processes, Markov chains, and Markov chains with special structures. Following the introductory chapters on probability theory and stochastic processes, we will disregard the various possible interpretations concerning the examples to emphasize terms, methodology, and analytical skills; therefore, we will provide the proofs for each of the given examples. We think that this structure will help readers to study the material more effectively since they may have different backgrounds and knowledge concerning this area. Regarding the basics of probability theory, we refer the interested reader to the books [21, 31, 38, 84]. With respect to the general results of stochastic processes and Markov chains, we refer the reader to the following comprehensive literature: [22, 26, 35, 36, 48, 49, 54, 71].

In Part II, the book introduces and considers the classic results of Markov and non-Markov queueing systems. Then queueing networks and applied queueing systems (analysis of ATM switches, conflict resolution methods of random access protocols, queueing systems with priorities, and repeated orders queueing systems) are analyzed. For more on the classic results of queueing theory, we refer the reader to [8, 20, 39, 51, 55, 69, 82], whereas in connection with the modern theory of queueing and telecommunication systems the following books may be consulted: [6, 7, 14–16, 34, 41, 47, 83], as well as results published mainly in journals and conference papers. The numerous exercises at the end of the chapters ensure a better understanding of the material.

A short appendix appears at the end of the book that sums up those special concepts and ideas that are used in the book and that help the reader to understand the material better.

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The book is recommended for students and researchers studying and working in the field of queueing theory and its applications.

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