Preface

It is not as if there are not many books already on queueing theory! So, why this one – an additional book? Well, generally queueing models and their analyses can be presented in several different ways, ranging from the highly theoretical base to the very applied base. I have noticed that most queueing books are written based on the former approach, with mathematical rigour and as a result sometimes ignoring the application oriented reader who simply wants to apply the results to a real life problem. In other words, that reader who has a practical queueing problem in mind and needs an approach to use for modelling such a system and obtain numerical measures to assist in understanding the system behaviour. Other books that take the purely applied approach usually oversimplify queueing models and analyses to the extend that a reader is not able to find results useful enough for the major applications intended. For example, the models are limited to simple unrealistic arrival and service processes and rules of operation, in an attempt to obtain very simple analysis which may not capture the key behaviour of the system. One of the challenges is to present queueing models and clearly guide the reader on how to use available mathematical tools to help in analyzing the problems associated with the models. To this end the contents of this book are mainly presented in a form that makes their applications very easy to see, as such it is written to make queueing analysis easier to follow and also to make the new developments and results in the field more accessible to pragmatic user of the models.

Nearly every queueing model can be set up as a Markov chain, even though some of them may end with huge state space. Markov chains have been very well studied in the field of applied stochastic processes. There are a class of Markov chains for which the matrix-analytic methods (MAM) are very suitable to their analysis. Most queueing models fall in that category. Hence there is definitely value in developing queueing models based on Markov chains and then using MAM for their analyses. The philosophy behind this book is that for most practical queueing problems that can be reduced to single node system, we can set them up as Markov chains. If so, then we can apply the results from the rich literature on Markov chains and MAM. One whole chapter is devoted to Markov chains in this book. That chapter focuses on Markov chain results and those specific to MAM that will be needed for the

single node analysis. So most of the analysis techniques employed in this book are based on MAM. Once a while the z-transform equivalent of some of the results are developed as alternatives. However, the use of transforms is not a major focus of this book. The book by Bruneel and Kim [28] focused on transform approach and the reader who has interest in that topic are referred to that book. Additional results on discrete time approach for queues using z-transforms can be found by visiting Professor Bruneel Herwig's website.

It is well known that single node queues do give some very good insights to even the very complex non-single node queues if properly approximated. So single node queues are very important in the field of queueing theory and are encountered very frequently. This book focuses on single node queues for that reason. Queueing networks in discrete time are dealt with in the book by Daduna [34].

One important area where queueing theory is applied very frequently is in the field of telecommunications. Telecommunication systems are analyzed in discrete time these days because it is based mainly on discrete technology; time is slotted and the system has shifted from analogue technology to discrete one. Hence discrete time queueing models need special consideration in the fields of queueing and telecommunications.

The first chapter of this book introduces single node queueing systems and discusses discrete time briefly. We believe, and also want to show in this queueing book, that most single node queues in discrete time can be set up as discrete time Markov chains, and all we need to do is apply the results from Markov chain. As a result we present, in Chapter 2, the key results from discrete time Markov chains, especially those related to MAM, that will be used to analyze our single node queueing systems. Generally, for most practical queueing problems we find ourselves turning to recursive schemes and hence needing to use some special computational procedures. Emphasis is placed on computational approaches for analysing some classes of Markov chains in Chapter 2. As we get into Chapters 3 and 4 where single node queues are dealt with the reader will see that the real creative work in developing the queuing models is in setting them up as Markov chains. After that we simply apply the results presented in Chapter 2. This is what is special about this book – that all we need is to understand some key results in discrete time Markov chains and we can analyze most single node queues. To summarize the philosophy used in this book, Chapter 2 actually contains the tools needed to analyze single node queues considered in this book, and the materials presented in Chapters 4 and 5 are mainly developing and also showing how to develop some key single server queueing models. For each of the models presented in Chapters 4 and 5, the reader is pointed to the Markov chain results in Chapter 2 that can be used for the queueing models' analyses. Chapter 3 presents general material that characterize queueing systems, including the very common distributions used to characterize the interarrival and service times.

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