An Introduction To Queueing Theory Modeling And Analysis In Applications Statistics For Industry And Technology

This unique textbook comprehensively introduces the field of discrete event systems, offering a breadth of coverage that makes the material accessible to readers of varied backgrounds. The book emphasizes a unified modeling framework that transcends specific application areas, linking the following topics in a coherent manner: language and automata theory, supervisory control, Petri net theory, Markov chains and queueing theory, discrete-event simulation, and concurrent estimation techniques. Topics and features: detailed treatment of automata and language theory in the context of discrete event systems, including application to state estimation and diagnosis comprehensive coverage of centralized and decentralized supervisory control of partially-observed systems timed models, including timed automata and hybrid automata stochastic models for discrete event systems and controlled Markov chains discrete event simulation an introduction to stochastic hybrid systems sensitivity analysis and optimization of discrete event and hybrid systems new in the third edition: opacity properties, enhanced coverage of supervisory control, overview of latest software tools This proven textbook is essential to advanced-level students and researchers in a variety of disciplines where the study of discrete event systems is relevant: control, communications, computer engineering, computer science, manufacturing engineering, transportation networks, operations research, and industrial engineering. Christos G. Cassandras is Distinguished Professor of Engineering, Professor of Systems Engineering, and Professor of Electrical and Computer Engineering at Boston University. Stéphane Lafortune is Professor of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor.

Introduction to Queueing Networks Second Edition Erol Gelenbe, Duke University, North Carolina, USA and Guy Pujolle, University of Versailles, France With new concepts emerging in recent literature, this is a timely update to a highly successful and well established first edition. Queueing networks are particularly important as digital communications continue to grow; this text provides a through and comprehensive introduction to the concept of applying mathematical queueing network theory to data communications. New additions: * G-nets, i.e. generalized (or "Gelenbe") queueing networks which allow the analysis of on-line network control functions such as traffic re-routing, * discrete time queueing networks with application to ATM networks As leading authorities in this area, the authors' focus on the practical approach where aspects of queueing theory are applied directly to communications systems and networks. Included is a series of exercises and examples at the end of each chapter as well as a fully annotated bibliography. This book is of particular interest to communications and computer engineers and is essential reading for network. managers and administrators. It will also benefit students and researchers in the area of networks, as well as Web server administrators and personal computer users. Visit Our Web Page! http://www.wiley.com/

Written with computer scientists and engineers in mind, this book brings queueing theory decisively back to computer science.

A Useful Guide to the Interrelated Areas of Differential Equations, Difference Equations, and Queueing Models Difference and Differential Equations with Applications in Queueing Theory presents the unique connections between the methods and applications of differential equations, difference equations, and Markovian queues. Featuring a comprehensive collection of topics that are used in stochastic processes, particularly in queueing theory, the book thoroughly discusses the relationship to systems of linear differential difference equations. The book demonstrates the applicability that queueing theory has in a variety of fields including telecommunications, traffic engineering, computing, and the design of factories, shops, offices, and hospitals. Along with the needed prerequisite fundamentals in probability, statistics, and Laplace transform, Difference and Differential Equations with Applications in Queueing Theory provides: A discussion on splitting, delayed-service, and delayed feedback for single-server, multiple-server, parallel, and series queue models Applications in queue models whose solutions require differential difference equations and generating function methods Exercises at the end of each chapter along with select answers The book is an excellent resource for researchers and practitioners in applied mathematics, operations research, engineering, and industrial engineering, as well as a useful text for upper-undergraduate and graduate-level courses in applied mathematics, differential and difference equations, queueing theory, probability, and stochastic processes.

Queueing Theory 1

Introduction to Queueing Systems with Telecommunication Applications

Modeling and Analysis in Applications

and Matrix-Analytic Methods

Queueing Theory

Critically acclaimed text for computer performance analysis--now in its second edition The Second Edition of this now-classic text provides a current and thorough treatment of queueing systems, queueing networks, continuous and discrete-time Markov chains, and simulation. Thoroughly updated with new content, as well as new problems and worked examples, the text offers readers both the theory and practical guidance needed to conduct performance and reliability evaluations of computer, communication, and manufacturing systems. Starting with basic probability theory, the text sets the foundation for the more complicated topics of queueing networks and Markov chains, using applications and examples to illustrate key points. Designed to engage the reader and build practical performance analysis skills, the text features a wealth of problems that mirror actual industry challenges. New features of the Second Edition include: * Chapter examining simulation methods and applications * Performance analysis applications for wireless, Internet, J2EE, and Kanban systems * Latest material on non-Markovian and fluid stochastic Petri nets, as well as solution techniques for Markov regenerative processes * Updated discussions of new and popular performance analysis tools, including ns-2 and OPNET * New and current real-world examples, including DiffServ routers in the Internet and cellular mobile networks With the rapidly growing complexity of computer and communication systems, the need for this text, which expertly mixes theory and practice, is tremendous. Graduate and advanced undergraduate students in computer science will find the extensive use of examples and problems to be vital in mastering both the basics and the fine points of the field, while industry professionals will find the text essential for developing systems that comply with industry standards and regulations.

To Queue Or Not To Queue: Equilibrium Behavior in Queueing Systems focuses on the highly interesting, practical viewpoint of customer behavior and its effect on the performance of the queueing system. The book's objectives are threefold: (1) It is a comprehensive survey of the literature on equilibrium behavior of customers and servers in queueing systems. The literature is rich and considerable, but lacks continuity. This book will provide the needed continuity and cover some issues that have not been adequately treated. (2) In addition, it will examine the known results of the field, classify them and identify where and how they relate to each other. (3) And finally, it seeks to fill a number of the gaps in the literature with new results while explicitly outlining open problems in other areas. With this book, it is the authors' paramount purpose is to motivate further research and to help researchers identify new and interesting open problems.

Queueing Theory with Applications to Packet Telecommunication is an efficient introduction to fundamental concepts and principles underlying the behavior of queueing systems and its application to the design of packet-oriented electrical communication systems. In addition to techniques and approaches found in earlier works, the author presents a thoroughly modern computational approach based on Schur decomposition. This approach facilitates solution of broad classes of problems wherein a number of practical modeling issues may be explored. Key features of communication systems, such as correlation in packet arrival processes at IP switches and variability in service rates due to fading wireless links are introduced. Numerous exercises embedded within the text and problems at the end of certain chapters that integrate lessons learned across multiple sections are also included. In all cases, including systems having priority, developments lead to procedures or formulae that yield numerical results from which sensitivity of queueing behavior to parameter variation can be explored. In several cases multiple approaches to computing distributions are presented. Queueing Theory with Applications to Packet Telecommunication is intended both for self study and for use as a primary text in graduate courses in queueing theory in electrical engineering, computer science, operations research, and mathematics. Professionals will also find this work invaluable because the author discusses applications such as statistical multiplexing, IP switch design, and wireless communication systems. In addition, numerous modeling issues, such as the suitability of Erlang-k and Pade approximations are addressed.

The aim of this book is to reflect the current cutting-edge thinking and established practices in the investigation of queueing systems and networks. This first volume includes ten chapters written by experts well-known in their areas. The book studies the analysis of queues with interdependent arrival and service times, characteristics of fluid queues, modifications of retrial queueing systems and finite-source retrial queues with random breakdowns, repairs and customers' collisions. Some recent tendencies in the asymptotic analysis include the average and diffusion approximation of Markov queueing systems and networks, the diffusion and Gaussian limits of multi-channel queueing networks with rather general input flow, and the analysis of two-time-scale nonhomogenous Markov chains using the large deviations principle. The book also analyzes transient behavior of infinite-server queueing models with a mixed arrival process, the strong stability of queueing systems and networks, and applications of fast simulation methods for solving high-dimension combinatorial problems.

Introduction to Discrete Event Systems

To Queue or Not to Queue

Foundations of Queueing Theory

Modeling and Performance Evaluation with Computer Science Applications

Vacation Queueing Models

The book aims to highlight the fundamental concepts of queueing systems. It starts with the mathematical modeling of the arrival process (input) of customers to the system. It is shown that the arrival process can be described mathematically either by the number of arrival customers in a fixed time interval, or by the interarrival time between two consecutive arrivals. In the analysis of queueing systems, the book emphasizes the importance of exponential service time of customers. With this assumption of exponential service time, the analysis can be simplified by using the birth and death process as a model. Many queueing systems can then be analyzed by choosing the proper arrival rate and service rate. This facilitates the analysis of many queueing systems. Drawing on the author's 30 years of experience in teaching and research, the book uses a simple yet effective model of thinking to illustrate the fundamental principles and rationale behind complex mathematical concepts. Explanations of key concepts are provided, while avoiding unnecessary details or extensive mathematical formulas. As a result, the text is easy to read and understand for students wishing to master the core principles of queueing theory. Contents:Modeling of Queueing SystemsQueueing Systems with LossesQueueing Systems Allowing WaitingThe Engset Loss and Delay SystemsQueueing Systems with a Single Server Readership: Researchers, academics, professionals and graduate students in electrical & electronic engineering, computer engineering and mathematical modeling. Keywords:Queueing Systems;Information Theory;Time Distribution Function

The book is composed of two main parts: mathematical background and queueing systems with applications. The mathematical background is a self containing introduction to the stochastic processes of the later studies queueing systems. It starts with a quick introduction to probability theory and stochastic processes and continues with chapters on Markov chains and regenerative processes. More recent advances of queueing systems are based on phase type distributions, Markov arrival processes and quasy birth death processes, which are introduced in the last chapter of the first part. The second part is devoted to queueing models and their applications. After the introduction of the basic Markovian (from M/M/1 to M/M/1//N) and non-Markovian (M/G/1, G/M/1) queueing systems, a chapter presents the analysis of queues with phase type distributions, Markov arrival processes (from PH/M/1 to MAP/PH/1/K). The next chapter presents the classical queueing network results and the rest of this part is devoted to the application examples. There are queueing models for bandwidth charing with different traffic classes, slotted multiplexers, ATM switches, media access protocols like Aloha and IEEE 802.11b, priority systems and retrial systems. An appendix supplements the technical content with Laplace and z transformation rules, Bessel functions and a list of notations. The book contains examples and exercises throughout and could be used for graduate students in engineering, mathematics and sciences.

Waiting in lines is a staple of everyday human life. Without really noticing, we are doing it when we go to buy a ticket at a movie theater, stop at a bank to make an account withdrawal, or proceed to checkout a purchase from one of our favorite department stores. Oftentimes, waiting lines are due to overcrowded, overfilling, or congestion; any time there is more customer demand for a service than can be provided, a waiting line forms. Queuing systems is a term used to describe the methods and techniques most ideal for measuring the probability and statistics of a wide variety of waiting line models. This book provides an introduction to basic queuing systems, such as M/M/1 and its variants, as well as newer concepts like systems with priorities, networks of queues, and general service policies. Numerical examples are presented to guide readers into thinking about practical real-world applications, and students and researchers will be able to apply the methods learned to designing queuing systems that extend beyond the classroom. Very little has been published in the area of queuing systems, and this volume will appeal to graduate-level students, researchers, and practitioners in the areas of management science, applied mathematics, engineering, computer science, and statistics.

This book provides the reader with the enhanced lecture material taken from a highly successful course in queueing theory that has been given, over the years, to students studying operational research. It is assumed that the reader has a good background in basic algebra, calculus and probability and from this foundation, mathematical models for a wide variety of interesting and realistic queueing systems are built. The models are carefully developed and illustrated with examples to show their application and potential. Readers are encouraged to test their own skills and proficiency through a number of exercises to which complete solutions are provided. Also covered, with worked examples, are birth-death models which can be used in a number of different areas. Models solved by using Markov Chains are discussed and similarly illustrated. Transient solutions, along with the important topics of queueing networks and simulation, with computer solutions for the latter, feature in the second half of the book. Finally, a recent development, the transient solution of an M/M/1 queue is given in a simple form easily understood by students.

Difference and Differential Equations with Applications in Queueing Theory

An Introduction to Queueing Systems

Performance Modeling and Design of Computer Systems

The Mathematics of Computer Performance Modeling

Queueing Networks and Markov Chains

*We will occasionally footnote a portion of text with a "**,, to indicate Notes on the that this portion can be initially bypassed. The reasons for bypassing a Text portion of the text include: the subject is a special topic that will not be referenced later, the material can be skipped on first reading, or the level of mathematics is higher than the rest of the text. In cases where a topic is self-contained, we opt to collect the material into an appendix that can be read by students at their leisure. The material in the text cannot be fully assimilated until one makes it Notes on "their own" by applying the material to specific problems. Self-discovery Problems is the best teacher and although they are no substitute for an inquiring mind, problems that explore the subject from different viewpoints can often help the student to think about the material in a uniquely per sonal way. With this in mind, we have made problems an integral part of this work and have attempted to make them interesting as well as informative.*

This book discusses systematically the many variations of vacation policy. The book discusses a variety of typical vacation model applications. The presentation style is unique compared with the books published in the same field – a "theorem and proof" format is used. Also, this is the first time G1/M/1 multi-server vacation models, both continuous and discrete, and the optimization and control issues have been presented in book form.

Probability, Markov Chains, Queues, and Simulation provides a modern and authoritative treatment of the mathematical processes that underlie performance modeling. The detailed explanations of mathematical derivations and numerous illustrative examples make this textbook readily accessible to graduate and advanced undergraduate students taking courses in which stochastic processes play a fundamental role. The textbook is relevant to a wide variety of fields, including computer science, engineering, operations research, statistics, and mathematics. The textbook looks at the fundamentals of probability theory, from the basic concepts of set-based probability, through probability distributions, to bounds, limit theorems, and the laws of large numbers. Discrete and continuous-time Markov chains are analyzed from a theoretical and computational point of view. Topics include the Chapman-Kolmogorov equations; irreducibility; the potential, fundamental, and reachability matrices; random walk problems; reversibility; renewal processes; and the numerical computation of stationary and transient distributions. The M/M/1 queue and its extensions to more general birth-death processes are analyzed in detail, as are queues with phase-type arrival and service processes. The M/G/1 and G/M/1 queues are solved using embedded Markov chains; the busy period, residual service time, and priority scheduling are treated. Open and closed queueing networks are analyzed. The final part of the book addresses the mathematical basis of simulation. Each chapter of the textbook concludes with an extensive set of exercises. An instructor's solution manual, in which all exercises are completely worked out, is also available (to professors only). Numerous examples illuminate the mathematical theories Carefully detailed explanations of mathematical derivations guarantee a valuable pedagogical approach Each chapter concludes with an extensive set of exercises

The definitive guide to queueing theory and its practical applications—features numerous real-world examples of scientific, engineering, and business applications Thoroughly updated and expanded to reflect the latest developments in the field, Fundamentals of Queueing Theory, Fifth Edition presents the statistical principles and processes involved in the analysis of the probabilistic nature of queues. Rather than focus narrowly on a particular application area, the authors illustrate the theory in practice across a range of fields, from computer science and various engineering disciplines to business and operations research. Critically, the text also provides a numerical approach to understanding and making estimations with queueing theory and provides comprehensive coverage of both simple and advanced queueing models. As with all preceding editions, this latest update of the classic text features a unique blend of the theoretical and timely real-world applications. The introductory section has been reorganized with expanded coverage of qualitative/non-mathematical approaches to queueing theory, including a high-level description of queues in everyday life. New sections on non-stationary fluid queues, fairness in queueing, and Little's Law have been added, as has expanded coverage of stochastic processes, including the Poisson process and Markov chains. • Each chapter provides a self-contained presentation of key concepts and formulas, to allow readers to focus independently on topics relevant to their interests • A summary table at the end of the book outlines the queues that have been discussed and the types of results that have been obtained for each queue • Examples from a range of disciplines highlight practical issues often encountered when applying the theory to real-world problems • A companion website features QtsPlus, an Excel-based software platform that provides computer-based solutions for most queueing models presented in the book. Featuring chapter-end exercises and problems—all of which have been classroom-tested and refined by the authors in advanced undergraduate and graduate-level courses—Fundamentals of Queueing Theory, Fifth Edition is an ideal textbook for courses in applied mathematics, queueing theory, probability and statistics, and stochastic processes. This book is also a valuable reference for practitioners in applied mathematics, operations research, engineering, and industrial engineering.

Queueing Theory for Telecommunications

Stochastic Processes in Queueing Theory

Fundamentals of Queuing Systems

Queueing Theory and Performance Evaluation

Performance Analysis of Queuing and Computer Networks

Queueing is an aspect of modern life that we encounter at every step in our daily activities. Whether it happens at the checkout counter in the supermarket or in accessing the Internet, the basic phenomenon of queueing arises whenever a shared facility needs to be accessed for service by a]arge number of jobs or customers. The study of queueing is important as it gravides both a theoretical background to the kind of service that we may expect from such a facility and the way in which the facility itself may be designed to provide some specified grade of service to its customers. Our study of queueing was basically motivated by its use in the study of communication systems and computer networks. The various computers, routers and switches in such a network may be modelled as individual queues. The whole system may itself be modelled as a queueing network providing the required service to the messages, packets or cells that need to be carried. Application of queueing theory provides the theoretical framework for the design and study of such networks. The purpose of this book is to support a course on queueing systems at the senior undergraduate or graduate levels. Such a course would then provide the theoretical background on which a subsequent course on the performance modeHing and analysis of computer networks may be based.

This introductory textbook is designed for a one-semester course on queueing theory that does not require a course on stochastic processes as a prerequisite. By integrating the necessary background on stochastic processes with the analysis of models, the work provides a sound foundational introduction to the modeling and analysis of queueing systems for a broad interdisciplinary audience of students in mathematics, statistics, and applied disciplines such as computer science, operations research, and engineering. This edition includes additional topics in methodology and applications. Key features: • An introductory chapter including a historical account of the growth of queueing theory in more than 100 years. • A modeling-based approach with emphasis on identification of models • Rigorous treatment of the foundations of basic models commonly used in applications with appropriate references for advanced topics. • A chapter on matrix-analytic method as an alternative to the traditional methods of analysis of queueing systems. • A comprehensive treatment of statistical inference for queueing systems. • Modeling exercises and review exercises when appropriate. The second edition of An Introduction of Queueing Theory may be used as a textbook by first-year graduate students in fields such as computer science, operations research, industrial and systems engineering, as well as related fields such as manufacturing and communications engineering. Upper-level undergraduate students in mathematics, statistics, and engineering may also use the book in an introductory course on queueing theory. With its rigorous coverage of basic material and extensive bibliography of the queueing literature, the work may also be useful to applied scientists and practitioners as a self-study reference for applications and further research. "...This book has brought a freshness and novelty as it deals mainly with modeling and analysis in applications as well as with statistical inference for queueing problems. With his 40 years of valuable experience in teaching and high level research in this subject area, Professor Bhat has been able to achieve what he aimed: to make [the work] somewhat different in content and approach from other books." - Assam Statistical Review of the first edition

Praise for the Third Edition "This is one of the best books available. Its excellent organizational structure allows quick reference to specific models and its clear presentation . . . solidifies the understanding of the concepts being presented." —IIE Transactions on Operations Engineering Thoroughly revised and expanded to reflect the latest developments in the field, Fundamentals of Queueing Theory, Fourth Edition continues to present the basic statistical principles that are necessary to analyze the probabilistic nature of queues. Rather than presenting a narrow focus on the subject, this update illustrates the wide-reaching, fundamental concepts in queueing theory and its applications to diverse areas such as computer science, engineering, business, and operations research. This update takes a numerical approach to understanding and making probable estimations relating to queues, with a comprehensive outline of simple and more advanced queueing models. Newly featured topics of the Fourth Edition include: Retrial queues Approximations for queueing networks Numerical inversion of transforms Determining the appropriate number of servers to balance quality and cost of service Each chapter provides a self-contained presentation of key concepts and formulae, allowing readers to work with each section independently, while a summary table at the end of the book outlines the types of queues that have been discussed and their results. In addition, two new appendices have been added, discussing transforms and generating functions as well as the fundamentals of differential and difference equations. New examples are now included along with problems that incorporate QtsPlus software, which is freely available via the book's related Web site. With its accessible style and wealth of real-world examples, Fundamentals of Queueing Theory, Fourth Edition is an ideal book for courses on queueing theory at the upper-undergraduate and graduate levels. It is also a valuable resource for researchers and practitioners who analyze congestion in the fields of telecommunications, transportation, aviation, and management science.

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Fundamentals of Queueing Theory

Statistical Methods for Analyzing Queuing Models

Equilibrium Behavior in Queueing Systems

Advanced Trends

Theory and Applications

The present textbook contains the recordsof a two-semester course on que- ing theory, including an introduction to matrix-analytic methods. This course comprises four hours oflectures and two hours of exercises per week andhas been taughtattheUniversity of Trier, Germany, for about ten years in - quence. The course is directed to last year undergraduate and?rst year gr- uate students of applied probability and computer science, who have already completed an introduction to probability theory. Its purpose is to present - terial that is close enough to concrete queueing models and their applications, while providing a sound mathematical foundation for the analysis of these. Thus the goal of the present book is two-fold. On the one hand, students who are mainly interested in applications easily feel bored by elaborate mathematical questions in the theory of stochastic processes. The presentation of the mathematical foundations in our courses is chosen to cover only the necessary results, which are needed for a solid foundation of the methods of queueing analysis. Further, students oriented - wards applications expect to have a justi?cation for their mathematical efforts in terms of immediate use in queueing analysis. This is the main reason why we have decided to introduce new mathematical concepts only when they will be used in the immediate sequel. On the other hand, students of applied probability do not want any heur- tic derivations just for the sake of yielding fast results for the model at hand.

This is a textbook on applied probability and statistics with computer science applications for students at the upper undergraduate level. It may also be used as a self study book for the practicing computer science professional. The successful first edition of this book proved extremely useful to students who need to use probability, statistics and queueing theory to solve problems in other fields, such as engineering, physics, operations research, and management science. The book has also been successfully used for courses in queueing theory for operations research students. This second edition includes a new chapter on regression as well as more than twice as many exercises at the end of each chapter. While the emphasis is the same as in the first edition, this new book makes more extensive use of available personal computer software, such as Minitab and Mathematica.

The object of queueing theory (or the theory of mass service) is the investigation of stochastic processes of a special form which are called queueing (or service) processes in this book. Two approaches to the definition of these processes are possible depending on the direction of investigation. In accordance with this fact, the exposition of the subject can be broken up into two self-contained parts. The first of these forms the content of this monograph. . The definition of the queueing processes (systems) to be used here is dose to the traditional one and is connected with the introduction of so-called governing random sequences. We will introduce algorithms which describe the governing of a system with the aid of such sequences. Such a definition inevitably becomes rather qualitative since under these conditions a completely formal construction of a stochastic process uniquely describing the evolution of the system would require introduction of a complicated phase space not to mention the difficulties of giving the distribution of such a process on this phase space.

The series is devoted to the publication of high-level monographs and surveys which cover the whole spectrum of probability and statistics. The books of the series are addressed to both experts and advanced students.

Theory ∩ Practice

An Elementary Introduction to Queueing Systems

An Introduction to Queueing Theory with Applications

Probability, Statistics, and Queueing Theory

The application of engineering principles in divergent fields such as management science and communications as well as the advancement of several approaches in theory and computation have led to growing interest in queueing models, creating the need for a comprehensive text. Emphasizing Markovian structures and the techniques that occur in differen

Performance Analysis of Queuing and Computer Networks develops simple models and analytical methods from first principles to evaluate performance metrics of various configurations of computer systems and networks. It presents many concepts and results of probability theory and stochastic processes. After an introduction to queues in computer networks, this self-contained book covers important random variables, such as Pareto and Poisson, that constitute models for arrival and service disciplines. It then deals with the equilibrium M/M/1/?queue, which is the simplest queue that is amenable for analysis. Subsequent chapters explore applications of continuous time, state-dependent single Markovian queues, the M/G/1 system, and discrete time queues in computer networks. The author then proceeds to study networks of queues with exponential servers and Poisson external arrivals as well as the G/M/1 queue and Pareto interarrival times in a G/M/1 queue. The last two chapters analyze bursty, self-similar traffic, and fluid flow models and their effects on queues.

This is a graduate level textbook that covers the fundamental topics in queuing theory. The book has a broad coverage of methods to calculate important probabilities, and gives attention to proving the general theorems. It includes many recent topics, such as server-vacation models, diffusion approximations and optimal operating policies, and more about bulk-arrival and bull-service models than other general texts. * Current, clear and comprehensive coverage * A wealth of interesting and relevant examples and exercises to reinforce concepts * Reference lists provided after each chapter for further investigation

The book is not intended to be characterized as either 'theoretical' or 'applied'. The emphasis of the book is on understanding the interplay of mathematical and heuristic reasoning that underlies queueing theory and its applications, with the following two objectives: 1) To give the student sufficient understanding of the theory so that he will be able to apply it in the practice of operations research, and 2) To give the student the background required to read the literature and embark on research.

Queueing Modelling Fundamentals

Introduction to Queueing Networks

Basic Queueing Theory

Discrete Time Modelling of a Single Node System

The Mathematical Basis of Performance Modeling

Intended for a first course in performance evaluation, this is a self-contained treatment covering all aspects of queuing theory. It starts by introducing readers to the terminology and usefulness of queueing theory and continues by considering Markovian queues in equilibrium, Littles law, reversibility, transient analysis, and computation, plus the M/G/1 queuing system. It then moves on to cover networks of queues, and concludes with techniques for numerical solutions, a discussion of the PANACEA technique, discrete time queueing systems and simulation, and stochastic Petri networks. The whole is backed by case studies of distributed queueing networks arising in industrial applications. This third edition includes a new chapter on self-similar traffic, many new problems, and solutions for many exercises.

Queueing theory applications can be discovered in many walks of life including; transportation, manufacturing, telecommunications, computer systems and more. However, the most prevalent applications of queueing theory are in the telecommunications field. Queueing Theory for Telecommunications: Discrete Time Modelling of a Single Node System focuses on discrete time modeling and illustrates that most queueing systems encountered in real life can be set up as a Markov chain. This feature is very unique because the models are set in such a way that matrix-analytic methods are used to analyze them. Queueing Theory for Telecommunications: Discrete Time Modelling of a Single Node System is the most relevant book available on queueing models designed for applications to telecommunications. This book presents clear concise theories behind how to model and analyze key single node queues in discrete time using special tools that were presented in the second chapter. The text also delves into the types of single node queues that are very frequently encountered in telecommunication systems modeling, and provides simple methods for analyzing them. Where appropriate, alternative analysis methods are also presented. This book is for advanced-level students and researchers concentrating on engineering, computer science and mathematics as a secondary text or reference book. Professionals who work in the related industries of telecommunications, industrial engineering and communications engineering will find this book useful as well.

The book examines the performance and optimization of systems where queueing and congestion are important constructs. Both finite and infinite queueing systems are examined. Many examples and case studies are utilized to indicate the breadth and depth of the queueing systems and their range of applicability. Blocking of these processes is very important and the book shows how to deal with this problem in an effective way and not only compute the performance measures of throughput, cycle times, and WIP but also to optimize the resources within these systems. The book is aimed at advanced undergraduate, graduate, and professionals and academics interested in network design, queueing performance models and their optimization. It assumes that the audience is fairly sophisticated in their mathematical understanding, although the explanations of the topics within the book are fairly detailed.

Queueing analysis is a vital tool used in the evaluation of system performance. Applications of queueing analysis cover a wide spectrum from bank automated teller machines to transportation and communications data networks. Fully revised, this second edition of a popular book contains the significant addition of a new chapter on Flow & Congestion Control and a section on Network Calculus among other new sections that have been added to remaining chapters. An introductory text, Queueing Modelling Fundamentals focuses on queueing modelling techniques and applications of data networks, examining the underlying principles of isolated queueing systems. This book introduces the complex queueing theory in simple language/proofs to enable the reader to quickly pick up an overview to queueing theory without utilizing the diverse necessary mathematical tools. It incorporates a rich set of worked examples on its applications to communication networks. Features include: Fully revised and updated edition with significant new chapter on Flow and Congestion Control as-well-as a new section on Network Calculus A comprehensive text which highlights both the theoretical models and their applications through a rich set of worked examples, examples of applications to data networks and performance curves Provides an insight into the underlying queuing principles and features step-by-step derivation of queueing results Written by experienced Professors in the field Queueing Modelling Fundamentals is an introductory text for undergraduate or entry-level post-graduate students who are taking courses on network performance analysis as well as those practicing network administrators who want to understand the essentials of network operations. The detailed step-by-step derivation of queueing results also makes it an excellent text for professional engineers.

A Course on Queueing Models

Probability, Stochastic Processes, and Queueing Theory

With Applications in Communication Networks

Stochastic Models in Queueing Theory

Queueing Theory with Applications to Packet Telecommunication

An Introduction to Queueing TheoryModeling and Analysis in ApplicationsBirkhäuser

Introduction to Queueing Theory

Computer Networks and Systems

Probability, Markov Chains, Queues, and Simulation

Queueing Theory in Action

An Introduction to Queueing Theory