Introduction To Statistical Communication Theory

Quantum Detection and Estimation Theory

Since the first edition of this book was published seven years ago, the field of modeling and simulation of communication systems has grown and matured in many ways, and the use of simulation as a day-to-day tool is now even more common practice. With the current interest in digital mobile communications, a primary area of application of modeling and simulation is now in wireless systems of a different flavor from the `traditional' ones. This second edition represents a substantial revision of the first, partly to accommodate the new applications that have arisen. New chapters include material on modeling and simulation of nonlinear systems, with a complementary section on related measurement techniques, channel modeling and three new case studies; a consolidated set of problems is provided at the end of the book. Providing the underlying principles of digital communication and the design techniques of real-world systems, this textbook prepares senior undergraduate and graduate students for the engineering practices required in industry. Covering the core concepts, including modulation, demodulation, equalization, and channel coding, it provides step-by-step mathematical derivations to aid understanding of background material. In addition to describing the basic theory, the principles of system and subsystem design are introduced, enabling students to visualize the intricate connections between subsystems and understand how each aspect of the design supports the overall goal of achieving reliable communications. Throughout the book, theories are linked to practical applications with over 250 real-world examples, whilst 370 varied homework problems in three levels of difficulty enhance and extend the text material. With this textbook, students can understand how digital communication systems operate in the real world, learn how to design subsystems, and evaluate end-to-end performance with ease and confidence.

Statistical Methods for Communication Science is the only statistical methods volume currently available that focuses exclusively on statistics in communication research. Writing in a straightforward, personal style, author Andrew F. Hayes offers this accessible and thorough introduction to statistical methods, starting with the fundamentals of measurement and moving on to discuss such key topics as sampling procedures, probability, reliability, hypothesis testing, simple correlation and regression, and analyses of variance and covariance. Hayes takes readers through each topic with clear explanations and illustrations. He provides a multitude of examples, all set in the context of communication research, thus engaging readers directly and helping them to see the relevance and importance of statistics to the field of communication. Highlights of this text include: *thorough and balanced coverage of topics; *integration of classical methods with modern "resampling" approaches to inference; *consideration of practical, "real world" issues; *numerous examples and applications, all drawn from communication research; *up-to-date information, with examples justifying use of various techniques; and *a CD with macros, data sets, figures, and additional materials. This unique book can be used as a stand-alone classroom text, a supplement to traditional research methods texts, or a useful reference manual. It will be invaluable to students, faculty, researchers, and practitioners in communication, and it will serve to advance the understanding and use of statistical methods throughout the discipline.

Instruments of Communication: An Essay on Scientific Writing provides an introduction to the instruments of logic and language. This book focuses on what people use in their communications, such as the materials and forms by means of which people share their experiences, meanings, intentions, feelings, hopes, and understandings. Organized into five parts encompassing 20 chapters, this book begins with an overview of the different forms of inter-organic communication. This text then examines the particular case of rational communication wherein it results in a shared understanding. Other chapters consider a certain concept of brain-function that underlies the treatment of language. This book discusses as well the concept of communication, which is not simply a process of transmitting messages but a process of sharing experiences. The final chapter deals with the different ways of classifying social behavior and explores the associative basis of communication. This book is a valuable resource for scientists, physicists, physiologists, and psychologists.

Random signals and noise are present in many engineering systems and networks. Signal processing techniques allow engineers to distinguish between useful signals in audio, video or communication equipment, and interference, which disturbs the desired signal. With a strong mathematical grounding, this text provides a clear introduction to the fundamentals of stochastic processes and their practical applications to random signals and noise. With worked examples, problems, and detailed appendices, Introduction to Random Signals and Noise gives the reader the knowledge to design optimum systems for effectively coping with unwanted signals. Key features: Considers a wide range of signals and noise, including analogue, discrete-time and bandpass signals in both time and frequency domains. Analyses the basics of digital signal detection using matched filtering, signal space representation and correlation receiver. Examines optimal filtering methods and their consequences. Presents a detailed discussion of the topic of Poisson processes and shot noise. An excellent resource for professional engineers developing communication systems, semiconductor devices, and audio and video equipment, this book is also ideal for senior undergraduate and graduate students in Electronic and Electrical Engineering.

This book was written as a first treatment of statistical com munication theory and communication systems at a senior graduate level. The only formal prerequisite is a knowledge of ele mentary calculus; however, some familiarity with linear systems and transform theory will be helpful. Chapter 1 is introductory and contains no substantial techni cal material. Chapter 2 is an elementary introduction to probability theory at a nonrigorous and non abstract level. It is essential to the remainder of the book but may be skipped (or reviewed has tily) by any student who has taken a one-semester undergraduate course in probability. Chapter 3 is a brief treatment of random processes and spec tral analysis. It includes an introduction to shot noise (Sections 3.14-3.17) which is not subsequently used explicitly. Chapter 4 considers linear systems with random inputs. It includes a considerable amount of material on narrow-band sys tems and on the representation of random processes. Chapter 5 treats the matched filter and the linear least mean-squared-error filter at an elementary level but in some detail. Numerous examples are provided throughout the book. Many of these are of an elementary nature and are intended merely to illustrate textual material. A reasonable number of problems of varying difficulty are provided. Instructors who adopt the text for classroom use may obtain a Solutions Manual for most of the problems by writing to the author.

This is the fourteenth volume in the series of Memorial Tributes compiled by the National Academy of Engineering as a personal remembrance of the lives and outstanding achievements of its members and foreign associates. These volumes are intended to stand as an enduring record of the many contributions of engineers and engineering to the benefit of humankind. In most cases, the authors of the tributes are contemporaries or colleagues who had personal knowledge of the interests and the engineering accomplishments of the deceased.

Due to a steady flow of requests over several years, Springer-Verlag now provides a corrected reprint of this text. It is designed to serve as a text for a first semester graduate level course for students in digital communication systems. As a pre requisite, it is presumed that the reader has an understanding of basic probability and stochastic processes. The treatment of digital communications in this book is intended to serve as an introduction to the subject. Part one is a development of the elements of statistical communication theory and radar detection. The text begins with a general model of a communication system which is extensively developed and the performance analyses of various conventional systems. The first part also serves as introductory material for the second part of the text which is a comprehensive study of the theory of transmitter optimization for coherent and noncoherent digital commu nication systems, that is, the theory of signal design.

Helping students develop a good understanding of asymptotic theory, Introduction to Statistical Limit Theory provides a thorough yet accessible treatment of common modes of convergence and their related tools used in statistics. It also discusses how the results can be

applied to several common areas in the field.The author explains as much of the

Authoritative introduction covers the role of Green's function in mathematical physics, essential differences between spatial and time filters, fundamental relations of paraxial optics, and effects of aberration terms on image formation. "An excellent book; well-organized, and well-written." — Journal of the Optical Society of America. 80 illustrations. 1963 edition.

Scientific knowledge grows at a phenomenal pace--but few books have had as lasting an impact or played as important a role in our modern world as The Mathematical Theory of Communication, published originally as a paper on communication theory more than fifty years ago. Republished in book form shortly thereafter, it has since gone through four hardcover and sixteen paperback printings. It is a revolutionary work, astounding in its foresight and contemporaneity. The University of Illinois Press is pleased and honored to issue this commemorative reprinting of a classic.

A systematic guide to detection and estimation theory and their applications in the design, implementation and optimization of real-world systems.

This monograph summarizes the special functions needed in the performance analysis of wireless communications systems. On the basis of special Gaussian and Owen functions, the methodology for the calculation of the relationship for symbol and bit error probabilities with coherent reception, for the two-dimensional multi-positional signal constructions in communications channel with deterministic parameters and additive white Gaussian noise (AWGN), was developed. To explain the concepts, examples are provided after the mathematical proofs to illustrate how the theorems could be applied; this includes symbol and bit error probability formulas receiving for present signal constructions (QAM, PSK, APSK and HEX), and error probability dependencies from signal-to-noise ratio (SNR). There are many books in communications theory dealing with several topics covered in this monograph, but none has consolidated all error probability calculations in a single book. This book therefore serves a very niche area. This text is written for graduate students, researchers, and professionals specializing in wireless communications and electrical engineering; dealing with probability and statistics, approximation, and analysis & differential equations. Contents:Special Integral Gaussian Q-functionSpecial Integral Owen T-functionExact Relations for Symbol and Bit Error Probability on Coherent Reception of Two-Dimensional Multipositional Signal ConstructionsSpecial Integral H-functionSpecial Integral S-functionSpecial Integral H(L)-functions and S(L)-functions Readership: Graduate students, researchers, and professionals specializing in Wireless Communications and Electrical Engineering; dealing with Probability and Statistics, Approximation, and Analysis & Differential Equations. Key Features:Keywords:Special Integral Functions;Wireless Communication;Fading Channels;Nakagami Distribution;Rice Distribution;Rayleigh Distribution;Bit Error Probability (BEP);Symbol Error Probability (SEP);Quadrature Amplitude Modulation (QAM);Phase Shift Keying (PSK);Amplitude Phase Shift Keying (APSK);Gaussian Q-function;Owen T-function;Marcum Q-function

Mathematics in Science and Engineering, Volume 39: Statistical Decision Theory in Adaptive Control Systems focuses on the combination of control theory with statistical decision theory. This volume is divided into nine chapters. Chapter 1 reviews the history of control theory and introduces statistical decision theory. The mathematical description of random processes is covered in Chapter 2. In Chapter 3, the basic concept of statistical decision theory is treated, while in Chapter 4, the method of solving statistical decision problems is described. The application of statistical decision concepts to control problems is explained in Chapter 5. Chapter 6 elaborates a method of designing an adaptive control system. An application of the sequential decision procedure to the design of decision adaptive control systems is illustrated in Chapter 7. Chapter 8 is devoted to the description of a method of the adaptive adjustment of parameters contained in nonlinear control systems, followed by a discussion of the future problems in applications of statistical decision theory to control processes in the last chapter. This book is recommended for students and researchers concerned with statistical decision theory in adaptive control systems.

Convenient access to information from every area of mathematics: Fourier transforms, Z transforms, linear and nonlinear programming, calculus of variations, random-process theory, special functions, combinatorial analysis, game theory, much more.

This handbook covers basic concepts of Information and mathematical theory that deals with the fundamental aspects of communication systems. The purpose of this Hand-Book is to develop the foundation ideas of information theory and to indicate where and how the theory can be applied in a real-time scenario and applications. The Handbook is categorized into two parts (PART - I & PART - II) The objectivesof this Handbook is to Explain the concepts of information source and entropy, Demonstrate the working of various Encoding Techniques, Discuss various source encoding algorithms, Illustrate the use of Cyclic and convolution codes. The readers reliability from this Handbook is to Build the basic concepts of information source and measure of information, Apply different Encoding Schemes for given applications, Develop the different Source Encoding Algorithm for given applications.

This IEEE Classic Reissue provides at an advanced level, a uniquely fundamental exposition of the applications of Statistical Communication Theory to a vast spectrum of important physical problems. Included are general analysis of signal detection, estimation, measurement, and related topics involving information transfer. Using the statistical Bayesian viewpoint, renowned author David Middleton employs statistical decision theory specifically tailored for the general tasks of signal processing. Dr. Middleton also provides a special focus on physical modeling of the canonical channel with real-world examples relating to radar, sonar, and general telecommunications. This book offers a detailed treatment and an array of problems and results spanning an exceptionally broad range of technical subjects in the communications field. Complete with special functions, integrals, solutions of integral equations, and an extensive, updated bibliography by chapter, An Introduction to Statistical Communication Theory is a seminal reference, particularly for anyone working in the field of communications, as well as in other areas of statistical physics. (Originally published in 1960.)

The book is based on the observation that communication is the central operation of discovery in all the sciences. In its "active mode" we use it to "interrogate" the physical world, sending appropriate "signals" and receiving nature's "reply". In the "passive mode" we receive nature's signals directly. Since we never know a prioriwhat particular return signal will be forthcoming, we must necessarily adopt a probabilistic model of communication. This has developed over the approximately seventy years since it's beginning, into a Statistical Communication Theory (or SCT). Here it is the set or ensemble of possible results which is meaningful. From this ensemble we attempt to construct in the appropriate model format, based on our understanding of the observed physical data and on the associated statistical mechanism, analytically represented by suitable probability measures. Since its inception in the late '30's of the last century, and in particular subsequent to World War II, SCT has grown into a major field of study. As we have noted above, SCT is

applicable to all branches of science. The latter itself is inherently and ultimately probabilistic at all levels. Moreover, in the natural world there is always a random background "noise" as well as an inherent a priori uncertainty in the presentation of deterministic observations, i.e. those which are specifically obtained, a posteriori. The purpose of the book is to introduce Non-Gaussian statistical communication theory and demonstrate how the theory improves probabilistic model. The book was originally planed to include 24 chapters as seen in the table of preface. Dr. Middleton completed first 10 chapters prior to his passing in 2008. Bibliography which represents remaining chapters are put together by the author's close colleagues; Drs. Vincent Poor, Leon Cohen and John Anderson. email pressbooks@ieee.org to request Ch.10

This comprehensive, flexible text is used in both one- and two-semester courses to review introductory through intermediate statistics. Instructors select the topics that are most appropriate for their course. Its conceptual approach helps students more easily understand the concepts and interpret SPSS and research results. Key concepts are simply stated and occasionally reintroduced and related to one another for reinforcement. Numerous examples demonstrate their relevance. This edition features more explanation to increase understanding of the concepts. Only crucial equations are included. In addition to updating throughout, the new edition features: New co-author, Debbie L. Hahs-Vaughn, the 2007 recipient of the University of Central Florida's College of Education Excellence in Graduate Teaching Award. A new chapter on logistic regression models for today's more complex methodologies. More on computing confidence intervals and conducting power analyses using G*Power. Many more SPSS screenshots to assist with understanding how to navigate SPSS and annotated SPSS output to assist in the interpretation of results. Extended sections on how to write-up statistical results in APA format. New learning tools including chapter-opening vignettes, outlines, and a list of key concepts, many more examples, tables, and figures, boxes, and chapter summaries. More tables of assumptions and the effects of their violation including how to test them in SPSS. 33% new conceptual, computational, and all new interpretative problems. A website that features PowerPoint slides, answers to the even-numbered problems, and test items for instructors, and for students the chapter outlines, key concepts, and datasets that can be used in SPSS and other packages, and more. Each chapter begins with an outline, a list of key concepts, and a vignette related to those concepts. Realistic examples from education and the behavioral sciences illustrate those concepts. Each example examines the procedures and assumptions and provides instructions for how to run SPSS, including annotated output, and tips to develop an APA style write-up. Useful tables of assumptions and the effects of their violation are included, along with how to test assumptions in SPSS. 'Stop and Think' boxes provide helpful tips for better understanding the concepts. Each chapter includes computational, conceptual, and interpretive problems. The data sets used in the examples and problems are provided on the web. Answers to the odd-numbered problems are given in the book. The first five chapters review descriptive statistics including ways of representing data graphically, statistical measures, the normal distribution, and probability and sampling. The remainder of the text covers inferential statistics involving means, proportions, variances, and correlations, basic and advanced analysis of variance and regression models. Topics not dealt with in other texts such as robust methods, multiple comparison and nonparametric procedures, and advanced ANOVA and multiple and logistic regression models are also reviewed. Intended for one- or two-semester courses in statistics taught in education and/or the behavioral sciences at the graduate and/or advanced undergraduate level, knowledge of statistics is not a prerequisite. A rudimentary knowledge of algebra is required.

Increasing the noise immunity of complex signal processing systems is the main problem in various areas of signal processing. At the present time there are many books and periodical articles devoted to signal detection, but many important problems remain to be solved. New approaches to complex problems allow us not only to summarize investigations, but also to improve the quality of signal detection in noise. This book is devoted to fundamental problems in the generalized approach to signal processing in noise based on a seemingly abstract idea: the introduction of an additional noise source that does not carry any information about the signal in order to improve the qualitative performance of complex signal processing systems. Theoretical and experimental studies carried out by the author lead to the conclusion that the proposed generalized approach to signal processing in noise allows us to formulate a decision-making rule based on the determi nation of the jointly sufficient statistics of the mean and variance of the likelihood function (or functional). Classical and modern signal detection theories allow us to define only the sufficient statistic of the mean of the likelihood function (or functional). The presence of additional information about the statistical characteristics of the like lihood function (or functional) leads to better-quality signal detection in comparison with the optimal signal detection algorithms of classical and modern theories.

Detailed coverage of probability theory, random variables and their functions, stochastic processes, linear system response to stochastic processes, Gaussian and Markov processes, and stochastic differential equations. 1973 edition.

A thought-provoking look at statistical learning theory and its role in understanding human learning and inductive reasoning A joint endeavor from leading researchers in the fields of philosophy and electrical engineering, An Elementary Introduction to Statistical Learning Theory is a comprehensive and accessible primer on the rapidly evolving fields of statistical pattern recognition and statistical learning theory. Explaining these areas at a level and in a way that is not often found in other books on the topic, the authors present the basic theory behind contemporary machine learning and uniquely utilize its foundations as a framework for philosophical thinking about inductive inference. Promoting the fundamental goal of statistical learning, knowing what is achievable and what is not, this book demonstrates the value of a systematic methodology when used along with the needed techniques for evaluating the performance of a learning system. First, an introduction to machine learning is presented that includes brief discussions of applications such as image recognition, speech recognition, medical diagnostics, and statistical arbitrage. To enhance accessibility, two chapters on relevant aspects of probability theory are provided. Subsequent chapters feature coverage of topics such as

the pattern recognition problem, optimal Bayes decision rule, the nearest neighbor rule, kernel rules, neural networks, support vector machines, and boosting. Appendices throughout the book explore the relationship between the discussed material and related topics from mathematics, philosophy, psychology, and statistics, drawing insightful connections between problems in these areas and statistical learning theory. All chapters conclude with a summary section, a set of practice questions, and a reference sections that supplies historical notes and additional resources for further study. An Elementary Introduction to Statistical Learning Theory is an excellent book for courses on statistical learning theory, pattern recognition, and machine learning at the upper-undergraduate and graduate levels. It also serves as an introductory reference for researchers and practitioners in the fields of engineering, computer science, philosophy, and cognitive science that would like to further their knowledge of the topic.

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches, such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering

An introductory, graduate-level look at modern communications in general and radio communications in particular. This seminal presentation of the applications of communication theory to signal and receiver design brings you valuable insights into the fundamental concepts underlying today's communications systems, especially wireless communications. Coverage includes: AM, FM Phase Modulation, PCM, fading, and diversity receivers. This is a classic reissue of a book published by McGraw Hill in 1966.

Classical and modern theories have given us a degree of noise immunity by defining the sufficient statistic of the mean of the likelihood function. The generalized theory moves beyond these limitations to determine the jointly sufficient statistics of the mean and variance of the likelihood function. Signal and Image Processing in Navigational Systems introduces us to the generalized approach, and then delves rigorously into the theory and practical applications of this approach. This volume represents the most in-depth discussion of the generalized approach to date, providing many examples and computer models to demonstrate how this approach raises the upper limits of noise immunity for navigation systems, leading to better detection performances. This book is vital for signal and image processing experts, radar, communications, acoustics, and navigational systems designers, as well as professionals in the fields of statistical pattern recognition, biomedicine, astronomy, and robotics who wish to extend the boundaries of noise immunity and improve qualitative performance of their systems.

Statistical Theory of Signal Detection, Second Edition provides an elementary introduction to the theory of statistical testing of hypotheses that is related to the detection of signals in radar and communications technology. This book presents a comprehensive survey of digital communication systems. Organized into 11 chapters, this edition begins with an overview of the theory of signal detection and the typical detection problem. This text then examines the goals of the detection system, which are defined through an analogy with the testing of statistical hypotheses. Other chapters consider the noise fluctuations in terms of probability distributions whereby the statistical information is used to design a receiver that attains the maximum rate of successful detections in a long series of trials. This book discusses as well the criteria of success and failure in statistical situations. The final chapter deals with the types of stochastic signals. This book is a valuable resource for mathematicians and engineers.

David Middleton was a towering figure of 20th Century engineering and science and one of the founders of statistical communication theory. During the second World War, the young David Middleton, working with Van Fleck, devised the notion of the matched filter, which is the most basic method used for detecting signals in noise. Over the intervening six decades, the contributions of Middleton have become classics. This collection of essays by leading scientists, engineers and colleagues of David are in his honor and reflect the wide influence that he has had on many fields. Also included is the introduction by Middleton to his forthcoming book, which gives a wonderful view of the field of communication, its history and his own views on the field that he developed over the past 60 years. Focusing on classical noise modeling and applications, Classical, Semi-Classical and Quantum Noise includes coverage of statistical communication theory, non-stationary noise, molecular footprints, noise suppression, Quantum error correction, and other related topics.