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Communication for Practicing
Engineers

An engineer's introduction to concepts, algorithms, and advancements in Digital Signal Processing. This lucidly written resource makes extensive use of real-world examples as it

covers all the important design and engineering references. For second and third year introductory communication systems courses for undergraduates, or an introductory graduate course. This revision of Couch's authoritative text provides the latest treatment of digital communication systems. The author balances coverage of both digital and analog communication systems, with an emphasis on design. Students will gain a working knowledge of both classical mathematical and personal computer methods to analyze, design, and simulate modern communication systems. MATLAB is integrated throughout. This book provides an introduction to the basic concepts in digital communications for readers with little or no previous exposure to either digital or analog communications. The intent is to help learners develop a firm understanding of digital communication system engineering—and to enable them to conduct system-

level design and analysis for digital communication systems of the future. As a result, the book emphasizes the basic principles of digital communications theory and techniques, rather than presenting specific technologies for implementation. Chapter topics include probability and random variables—review and notation, introduction to random processes, linear filtering of random processes, frequency-domain analysis of random processes in linear systems, baseband transmission of binary data, coherent communications, noncoherent communications, intersymbol interference, and spread-spectrum communication systems. For individuals preparing for a career in wireless communications system design. This book primarily focuses on the design of analog and digital communication systems; and has been structured to cater to the second year engineering undergraduate students of Computer Science, Information

Technology, Electrical Engineering and Electronics and Communication departments. For better understanding, the basics of analog communication systems are outlined before the digital communication systems section. The content of this book is also suitable for the students with little knowledge in communication systems. The book is divided into five modules for efficient presentation, and it provides numerous examples and illustrations for the detailed understanding of the subject, in a thorough manner. Offers the most complete, up-to-date coverage available on the principles of digital communications. Focuses on basic issues, relating theory to practice wherever possible. Numerous examples, worked out in detail, have been included to help the reader develop an intuitive grasp of the theory. Topics covered include the sampling process, digital modulation techniques, error-control coding, robust quantization for pulse-code

modulation, coding speech at low bit radio, information theoretic concepts, coding and computer communication. Because the book covers a broad range of topics in digital communications, it should satisfy a variety of backgrounds and interests. Digital Communications is the result of the author's 38 years' experience in teaching, and in design and development of various wireless communication systems. It covers all primary areas in digital communication systems in engineering. The book intends to give the students a grasp of the basic issues of communication systems during transition from analog to digital. To make the reading interesting as well as systematic, conscious efforts have been made to explain the basics of technology, avoiding complex mathematics as far as possible. Numerical problems are then introduced to help the students fully understand the concepts and applications. **KEY FEATURES**• Complete and thorough introduction to the

analysis and design of digital communication systems• Concepts explained with practical applications derived from the personal experience of the author• Analytical steps of all derivation without any external reference• Numerous numerical examples to help students understand the fundamental applications of the concepts in practice Offers concise, practical knowledge on modern communication systems to help students transition smoothly into the workplace and beyond This book presents the most relevant concepts and technologies of today's communication systems and presents them in a concise and intuitive manner. It covers advanced topics such as Orthogonal Frequency-Division Multiplexing (OFDM) and Multiple-Input Multiple-Output (MIMO) Technology, which are enabling technologies for modern communication systems such as WiFi (including the latest enhancements) and LTE-Advanced. Following a brief

introduction to the field, *Digital Communication for Practicing Engineers* immerses readers in the theories and technologies that engineers deal with. It starts off with Shannon Theorem and Information Theory, before moving on to basic modules of a communication system, including modulation, statistical detection, channel coding, synchronization, and equalization. The next part of the book discusses advanced topics such as OFDM and MIMO, and introduces several emerging technologies in the context of 5G cellular system radio interface. The book closes by outlining several current research areas in digital communications. In addition, this text: Breaks down the subject into self-contained lectures, which can be read individually or as a whole Focuses on the pros and cons of widely used techniques, while providing references for detailed mathematical analysis Follows the current technology trends, including advanced topics such as OFDM and

MIMO Touches on content this is not usually contained in textbooks such as cyclostationary symbol timing recovery, adaptive self-interference canceler, and Tomlinson-Harashima precoder Includes many illustrations, homework problems, and examples *Digital Communication for Practicing Engineers* is an ideal guide for graduate students and professionals in digital communication looking to understand, work with, and adapt to the current and future technology. Provides a detailed, unified treatment of theoretical and practical aspects of digital and analog communication systems, with emphasis on digital communication systems. Integrates theory—keeping theoretical details to a minimum—with over 60 practical, worked examples illustrating real-life methods. Emphasizes deriving design equations that relate performance of functional blocks to design parameters. Illustrates how to trade off

between power, band-width and equipment complexity while maintaining an acceptable quality of performance. Material is modularized so that appropriate portions can be selected to teach several different courses. Includes over 300 problems and an annotated bibliography in each chapter. The renowned communications theorist Robert Gallager brings his lucid writing style to the study of the fundamental system aspects of digital communication for a one-semester course for graduate students. With the clarity and insight that have characterized his teaching and earlier textbooks, he develops a simple framework and then combines this with careful proofs to help the reader understand modern systems and simplified models in an intuitive yet precise way. A strong narrative and links between theory and practice reinforce this concise, practical presentation. The book begins with data compression for arbitrary sources. Gallager then describes how to

modulate the resulting binary data for transmission over wires, cables, optical fibers, and wireless channels. Analysis and intuitive interpretations are developed for channel noise models, followed by coverage of the principles of detection, coding, and decoding. The various concepts covered are brought together in a description of wireless communication, using CDMA as a case study. The renowned communications theorist Robert Gallager brings his lucid writing style to the study of the fundamental system aspects of digital communication for a one-semester course for graduate students. With the clarity and insight that have characterized his teaching and earlier textbooks, he develops a simple framework and then combines this with careful proofs to help the reader understand modern systems and simplified models in an intuitive yet precise way. A strong narrative and links between theory and practice reinforce this concise, practical presentation. The book begins

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all the parts fit together and interact as you build the complete receiver. In addition to coverage of crucial issues, such as timing, carrier recovery and equalization, the text contains over 400 practical exercises, providing invaluable preparation for industry, where wireless communications and software radio are becoming increasingly important. A variety of extra resources are also provided online, including lecture slides and a solutions manual for instructors. Digital communications is an elective course often taken as the second semester of an analog/digital sequence or as a follow-on course to communication systems. This new text offers the most complete, up-to-date coverage available on the principles of digital communications, focusing on core principles and relating theory to practice. Numerous examples, worked out in detail, have been included to help the reader develop an intuitive grasp of the theory. The text also incorporates MATLAB-based

computer experiments throughout, as well as themed examples and a large amount of quality homework problems. Because the book covers a broad range of topics in digital communications, it should satisfy a variety of backgrounds and interests. 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. One of the first books in this area, this text focuses on important aspects of the system operation, analysis and performance evaluation of selected chaos-based digital communications systems - a hot topic in communications and signal processing. The book covers fundamentals and basics of engineering communication theory. It presents right mix of explanation of mathematics (theory) and explanation. The book discusses both analogue communication and digital communication in details. It

covers the subject of 'classical' engineering communication starting from the very basics of the subject to the beginning of more advanced areas. It also covers all the basic mathematics which is required to read the text. It covers a two semester course as an undergraduate text and some topics in master's course as well. This book is for designers and would-be designers of digital communication systems. The general approach of this book is to extract the common principles underlying a range of media and applications and present them in a unified framework. Digital Communication is relevant to the design of a variety of systems, including voice and video digital cellular telephone, digital CATV distribution, wireless LANs, digital subscriber loop, metallic Ethernet, voiceband data modems, and satellite communication systems. New in this Third Edition: New material on recent advances in wireless communications, error-control coding, and multi-

user communications has been added. As a result, two new chapters have been added, one on the theory of MIMO channels, and the other on diversity techniques for mitigating fading. Error-control coding has been rewritten to reflect the current state of the art. Chapters 6 through 9 from the Second Edition have been reorganized and streamlined to highlight pulse-amplitude modulation, becoming the new Chapters 5 through 7. Readability is increased by relegating many of the more detailed derivations to appendices and exercise solutions, both of which are included in the book. Exercises, problems, and solutions have been revised and expanded. Three chapters from the previous edition have been moved to the book's Web site to make room for new material. This book is ideal as a first-year graduate textbook, and is essential to many industry professionals. The book is attractive to both audiences through the inclusion of many practical examples and a

practical flavor in the choice of topics. Digital Communication has a Web site at : <http://www.ece.gatech.edu/~barry/digital/>, where the reader may find additional information from the Second Edition, other supplementary materials, useful links, a problem solutions manual, and errata. "Digital Communications" presents the theory and application of the philosophy of Digital Communication systems in a unique but lucid form. The book inserts equal importance to the theory and application aspect of the subject whereby the authors selected a wide class of problems. The Salient features of the book are: 1. The foundation of Fourier series, Transform and wavelets are introduced in a unique way but in lucid language. 2. The application area is rich and resembles the present trend of research, as we are attached with those areas professionally. 3. Elegant exercise section is designed in such a way that, the readers can get the flavor of the subject and get attracted towards the

future scopes of the subject. 4. Unparallel tabular, flow chart based and pictorial methodology description will be there for sustained impression of the proposed design/algorithms in mind. A comprehensive and detailed treatment of the program SIMULINK® that focuses on SIMULINK® for simulations in Digital and Wireless Communications Modeling of Digital Communication Systems Using SIMULINK® introduces the reader to SIMULINK®, an extension of the widely-used MATLAB modeling tool, and the use of SIMULINK® in modeling and simulating digital communication systems, including wireless communication systems. Readers will learn to model a wide selection of digital communications techniques and evaluate their performance for many important channel conditions. Modeling of Digital Communication Systems Using SIMULINK® is organized in two parts. The first addresses Simulink® models of digital

communications systems using various modulation, coding, channel conditions and receiver processing techniques. The second part provides a collection of examples, including speech coding, interference cancellation, spread spectrum, adaptive signal processing, Kalman filtering and modulation and coding techniques currently implemented in mobile wireless systems. Covers case examples, progressing from basic to complex Provides applications for mobile communications, satellite communications, and fixed wireless systems that reveal the power of SIMULINK modeling Includes access to useable SIMULINK® simulations online All models in the text have been updated to R2018a; only problem sets require updating to the latest release by the user Covering both the use of SIMULINK® in digital communications and the complex aspects of wireless communication systems, Modeling of Digital Communication Systems Using SIMULINK® is a great

resource for both practicing engineers and students with MATLAB experience. This exciting revision of Communication Systems, a classic text in the communications field, presents an introduction to electrical communication systems, including analysis methods, design principles, and hardware considerations. The fifth edition has been updated to reflect current technology covering both analog and digital communication in this ever-evolving field. Conceptual/descriptive/thought questions have been added throughout the book as well as MATLAB® questions and lecture Powerpoint files on the website. The text covers both analog and digital communications. It features worked examples and exercises for students to solve within chapters, helping them to master new concepts as they are introduced. This book serves as an easily accessible reference for wireless digital communication systems. Topics are presented with simple but

non-trivial examples and then elaborated with their variations and sophistications. It includes numerous examples and exercises to illustrate key points. The book emphasizes both practical problem solving and a thorough understanding of fundamentals, aiming to realize the complementary relationship between practice and theory. Though the author emphasize wireless radio channels, the fundamentals that are covered are useful to different channels - digital subscriber line, coax, power lines, optical fibers, and even Gigabit serial interconnection. This book is the outgrowth of the author's hands-on experience in the telecommunication systems industry as a research and development engineer. It is written primarily for practitioners of wireless digital communication systems - engineers and technical leaders and managers - and for digital communication systems in general including new comers like graduate students and upper-division

undergraduate students. The material in chapters 5(OFDM), 6(Channel coding), 7(Synchronization) and 8(Transceivers) contains something new, not explicitly available in typical textbooks, and useful in practice. For example, in Chapter 5, all known orthogonal frequency division multiplex signals are formulated based on pulse shape and thus flexible, e.g., unlike currently predominant symbol block transmission, it can be serial transmission. In Chapter 6, we emphasize practical applications of powerful error coding such as LDPC to higher order modulations, fading, and non-linearity problem. In Chapter 7, new digital timing detectors are suggested for small access bandwidth shaping pulse, and a digital quadrature imbalance correction is also included along with digital carrier phase recovery. In Chapter 8, low IF digital image cancelling transceiver is treated in detail so that practical implementation can be readily done with advantages. A

concise introduction to the core concepts in digital communication, providing clarity and depth through examples, problems and MATLAB exercises. Its simple structure maps a logical route to understand the most basic principles in digital communication, and also leads students through more in-depth treatment with examples and step-by-step instructions. Featuring a variety of applications that motivate students, this book serves as a companion or supplement to any of the comprehensive textbooks in communication systems. The book provides a variety of exercises that may be solved on the computer using MATLAB. By design, the treatment of the various topics is brief. The authors provide the motivation and a short introduction to each topic, establish the necessary notation, and then illustrate the basic concepts by means of an example. Digital Signal Processing in Modern Communication Systems takes you on a journey that starts

with basic DSP principles and ends with a treatment of modern wireless modems like OFDM and single-tone transceivers. Throughout this journey, we will cover signal processing topics that are applicable not just to the field of communications but to many engineering disciplines. This text steps outside the often dry mathematical presentation of more traditional DSP books and provides a more intuitive approach to this fascinating topic. Some of this book's uniqueness can be summarized as follows: - An intuitive approach to the topic of digital signal processing. - Working in-book MatLab examples supporting all important concepts. - A large scope covering basic concepts (correlation, convolution, DFT, FIR filters ...) as well as advanced topics (optimization, adaptive signal processing, equalization, OFDM, MIMO ...). - MatLab modeling of analog/RF effects (multipath channel, thermal noise, phase noise, IQ imbalances, DC and frequency offsets) that must be

addressed and solved in modern modem design. - Real world topics that go beyond the ordinary communication textbooks such as signal synchronization, modem rate management, and fixed-point effects. All in all, this book is a must-have for students and practicing engineers who want to build upon the principles of Digital Signal Processing, enrich their understanding with advanced topics, and then apply that knowledge to the design of modern wireless modems. Combining theoretical knowledge and practical applications, this advanced-level textbook covers the most important aspects of contemporary digital communication systems. Introduction to Digital Communication Systems focuses on the rules of functioning digital communication system blocks, starting with the performance limits set by the information theory. Drawing on information relating to turbo codes and LDPC codes, the text presents the basic methods of error

correction and detection, followed by baseband transmission methods, and single- and multi-carrier digital modulations. The basic properties of several physical communication channels used in digital communication systems are explained, showing the transmission and reception methods on channels suffering from intersymbol interference. The text also describes the most recent developments in the transmission techniques specific to wireless communications used both in wireline and wireless systems. The case studies are a unique feature of this book, illustrating elements of the theory developed in each chapter. Introduction to Digital Communication Systems provides a concise approach to digital communications, with practical examples and problems to supplement the text. There is also a companion website featuring an instructors' solutions manual and presentation slides to aid understanding. Offers theoretical and practical

knowledge in a self-contained textbook on digital communications Explains basic rules of recent achievements in digital communication systems such as MIMO, turbo codes, LDPC codes, OFDMA, SC-FDMA Provides problems at the end of each chapter with an instructors' solutions manual on the companion website Includes case studies and representative communication system examples such as DVB-S, GSM, UMTS, 3GPP-LTE Unique in scope and content, this book incorporates all the major topics related to digital communications into a single volume. It examines, in some detail, the three mediums utilized in digital transmission--line-of-sight, satellite and optical fibers. Features practical examples of system design. Noise in Communications Systems. Voice Channel Digital Processing. Digital Radio. Line-of-Sight Microwave Links. Communications Satellites. Satellite Earth Stations. Satellite Access. Satellite Links. Optical Fiber

Communications. Optical-Fiber System Analysis and Design. System Measurements and Performance Evaluation. Elements of High Definition TV. For practicing Digital Communications engineers, engineers in other disciplines intending to enter the Digital Communications field, Scientists, Technical Managers, and Technologists. Introduction to Digital Communications explores the basic principles in the analysis and design of digital communication systems, including design objectives, constraints and trade-offs. After portraying the big picture and laying the background material, this book lucidly progresses to a comprehensive and detailed discussion of all critical elements and key functions in digital communications. The first undergraduate-level textbook exclusively on digital communications, with a complete coverage of source and channel coding, modulation, and synchronization. Discusses

major aspects of communication networks and multiuser communications. Provides insightful descriptions and intuitive explanations of all complex concepts. Focuses on practical applications and illustrative examples. A companion Web site includes solutions to end-of-chapter problems and computer exercises, lecture slides, and figures and tables from the text. This practical guide helps readers to learn how to develop and implement synchronization functions in digital communication systems. Digital Communication using MATLAB and Simulink is intended for a broad audience. For the student taking a traditional course, the text provides simulations of the MATLAB and Simulink systems, and the opportunity to go beyond the lecture or laboratory and develop investigations and projects. For the professional, the text facilitates an expansive review of and experience with the tenets of digital communication systems. Digital

communication systems have revolutionized the telecommunications industry in the present age. They have become an integral part of the corporate & business domains as well as different individual groups or consumer circles. There is a rising demand for conceptual and practical advancements in the field of digital communication systems. This extensive book encompasses some of the most significant concepts in digital communication that include mobile and wireless communication systems; frameworks, tools & techniques applied in digital communication systems; evaluation and application of digital communication systems in different spheres, etc. It contains researches and case-studies by experts and academicians from diverse regions of the world that discuss the latest improvements as well as innovations which would contribute to the overall development of next generation digital communication systems.

This book concerns digital communication. Specifically, we treat the transport of bit streams from one geographical location to another over various physical media, such as wire pairs, coaxial cable, optical fiber, and radio waves. Further, we cover the multiple access and synchronization issues relevant to constructing communication networks that simultaneously transport bit streams from many users. The material in this book is thus directly relevant to the design of a multitude of digital communication systems, including for example local and metropolitan area data networks, voice and video telephony systems, digital CATV distribution, digital cellular and radio systems, the narrowband and broadband integrated services digital network (ISDN), computer communication systems, voiceband data modems, and satellite communication systems. We extract the common principles underlying these and other applications and present them in a unified framework.

This book is intended for designers and would-be designers of digital communication systems. To limit the scope to manageable proportions we have had to be selective in the topics covered and in the depth of coverage. In the case of advanced information, coding, and detection theory, for example, we have not tried to duplicate the in-depth coverage of many advanced textbooks, but rather have tried to cover those aspects directly relevant to the design of digital communication systems. An accessible undergraduate textbook introducing key fundamental principles behind modern communication systems, supported by exercises, software problems and lab exercises. Digital communication as it is practiced in Africa today is at a crossroad. This edited collection takes that crossroad as its starting point, as it both examines the complicated present and looks to the uncertain future of African communication systems.

Contributing authors explore how western digital communication systems have proliferated in the African communication landscape, and argue that rich and long-cherished African forms of communal, in-person communication have been increasingly abandoned in favor of assimilation to western digital norms. As a result, future generations of Africans born on the continent and abroad may never recognize and appreciate African systems of communications.

Acknowledging that globalized digital communication systems are here to stay, the volume contends that in order to comprehend the past, present, and future of African communications, scholars need to decolonize their approach to teaching and consuming mediated and in-person communications on the African continent and abroad.

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. Annotation Digital Communication Systems Using SystemView describes the analysis and design of modern digital communication systems and the benefits of using this software. The concepts of digital communications system design, in particular the presence of noise, cannot be conveyed with simple calculations. It allows students and professionals to investigate the what-ifs of such design in a convenient simulation design environment. Professional engineers actively designing communication circuits who were not exposed to such systems or design simulation tools in their coursework are allowed to experiment with the what-ifs of digital communication systems design without conventional programming through the materials provided in this book.

Senior undergraduate or first level graduate students in electrical and computer engineering in a required or elective course in digital communication systems will find this the only complete description of the SystemView simulation environment. This text is suitable for students with or without prior knowledge of probability theory. Only after laying a solid foundation in how communication systems work do the authors delve into analyses that require probability theory and random processes. Revised and updated throughout, the fifth edition features over 200 fully worked-through examples incorporating current technology, MATLAB codes throughout, and a full review of key signals and systems concepts.

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