

Advanced Optical Communication Systems Networks Answers

This book presents coverage of the performance, design principles and analysis of optical communication systems operating under nonlinear propagation regimes. It includes an application based comparison of different systems, so that the reader can determine the right system for his application.

The advantages of optical communications are many: ultra-high speed, highly reliable information transmission, and cost-effective modulation and transmission links to name but a few. It is no surprise that optical fiber communications systems are now in extensive use all over the world. Along with software and microelectronics, optical communication represents a key technology of modern telecommunication systems. *Optical Communications: Components and Systems* provides the basic material required for advanced study in theory and applications of optical fiber and space communication systems. After a review of some fundamental background material, component-based chapters discuss all relevant passive and active optical and optoelectronic components used in point-to-point links and in networks. Systems chapters address the analysis and optimization of both incoherent and coherent systems, introduce fiber optic link design, and discuss physical limits. The authors also provide an overview of applications such as optical networks and optical free-space communications. The advanced interactive multimedia communications of today and the future rely on optical fiber and space communication techniques. *Optical Communications: Components and Systems* offers engineers and physicists a working reference for the selection and design of optical communication systems and provides engineering students with a valuable text that prepares them for work in this essential and rapidly growing field.

Optical methods of measurements are the most sensitive techniques of noncontact investigations, and at the same time, they are fast as well as accurate which increases reproducibility of observed results. In recent years, the importance of optical interferometry methods for research has dramatically increased, and applications range from precise surface testing to finding extrasolar planets. This book covers various aspects of optical interferometry including descriptions of novel apparatuses and methods, application interferometry for studying biological objects, surface qualities, materials characterization, and optical testing. The book includes a series of chapters in which experts share recent progress in interferometry through original research and literature reviews.

This textbook introduces the advanced topics of: (i) wireless communications, (ii) free-space optical (FSO) communications, (iii) indoor optical wireless (IR) communications, and (iv) fiber-optics communications and presents these different types of communication systems in a unified fashion for better practical

use. Fundamental concepts, such as propagation principles, modulation formats, channel coding, diversity principles, MIMO signal processing, multicarrier modulation, equalization, adaptive modulation and coding, detection principles, and software defined transmission are first described and then followed up with a detailed look at each particular system. The book is self-contained and structured to provide straightforward guidance to readers looking to capture fundamentals and gain theoretical and practical knowledge about wireless communications, optical communications, and fiber-optics communications, all which can be readily applied in studies, research, and practical applications. The textbook is intended for an upper undergraduate or graduate level course in optical communication. It features problems, an appendix with all background material needed, and homework.

Optical science and engineering affect almost every aspect of our lives. Millions of miles of optical fiber carry voice and data signals around the world. Lasers are used in surgery of the retina, kidneys, and heart. New high-efficiency light sources promise dramatic reductions in electricity consumption. Night-vision equipment and satellite surveillance are changing how wars are fought. Industry uses optical methods in everything from the production of computer chips to the construction of tunnels. Harnessing Light surveys this multitude of applications, as well as the status of the optics industry and of research and education in optics, and identifies actions that could enhance the field's contributions to society and facilitate its continued technical development.

Part 1 describes our work on high dynamic range optical analog links. Within Part 1, Chapter 1 covers linewidth-insensitive coherent amplitude-modulated links and Chapter 2 covers coherent angle-modulated links and linewidth-insensitive interferometric links. Part 2 describes our work on dynamic wavelength division multiplexing (WDM) networks. Within Part 2, Chapter 3 covers the physical layer of STARNET, a coherent WDM communication network built at Stanford. Chapter 4 addresses the impact of semiconductor laser linewidth on STARNET physical layer performance. Chapter 5 covers the electronic interface architecture of STARNET. Part 3 describes our work with nonlinear effects in fiber. Within Part 3, Chapter 6 covers the impact of fiber nonlinearities such as four-wave mixing (FWM), cross-phase modulation (XPM), stimulated Brillouin scattering (SBS), and fiber-induced parasitic phase modulation on optical communication systems. This report ends with conclusions and a list of publications generated during this project.

This books aims to present fundamental aspects of optical communication techniques and advanced modulation techniques and extensive applications of optical communications systems and networks employing single-mode optical fibers as the transmission system. New digital techqniues such as chromatic dispersion, polarization mode dispersion, nonlinear phase distortion effects, etc. will be discussed. Practical models for practice and understanding the behavior and dynamics of the devices and systems will be included.

This handbook is an authoritative, comprehensive reference on optical networks, the backbone of today's communication and information society. The book reviews the many underlying technologies that enable the global optical communications infrastructure, but also explains current research trends targeted towards continued capacity scaling and enhanced networking flexibility in support of an unabated traffic growth fueled by ever-emerging new applications. The book is divided into four parts: Optical Subsystems for Transmission and Switching, Core Networks, Datacenter and Super-Computer Networking, and Optical Access and Wireless Networks. Each chapter is written by world-renown experts that represent academia, industry, and international government and regulatory agencies. Every chapter provides a complete picture of its field, from entry-level information to a snapshot of the respective state-of-the-art technologies to emerging research trends, providing something useful for the novice who wants to get familiar with the field to the expert who wants to get a concise view of future trends.

The 2nd Edition of *Optical Wireless Communications: System and Channel Modelling with MATLAB®* with additional new materials, is a self-contained volume that provides a concise and comprehensive coverage of the theory and technology of optical wireless communication systems (OWC). The delivery method makes the book appropriate for students studying at undergraduate and graduate levels as well as researchers and professional engineers working in the field of OWC. The book gives a detailed description of OWC, focusing mainly on the infrared and visible bands, for indoor and outdoor applications. A major attraction of the book is the inclusion of Matlab codes and simulations results as well as experimental test-beds for free space optics and visible light communication systems. This valuable resource will aid the readers in understanding the concept, carrying out extensive analysis, simulations, implementation and evaluation of OWC links. This 2nd edition is structured into nine compact chapters that cover the main aspects of OWC systems: History, current state of the art and challenges Fundamental principles Optical source and detector and noise sources Modulation, equalization, diversity techniques Channel models and system performance analysis Visible light communications Terrestrial free space optics communications Relay-based free space optics communications Matlab codes. A number of Matlab based simulation codes are included in this 2nd edition to assist the readers in mastering the subject and most importantly to encourage them to write their own simulation codes and enhance their knowledge.

This volume addresses the problem of designing efficient signalling and provides a link between the areas of communication theory and modem design for amplitude constrained linear optical intensity channel. It provides practical guidelines for the design of signalling sets for wireless optical intensity channels.

The optical world is continuously and rapidly evolving, and new challenges arise every day. As a result of these rapid changes, the need for up-to-date texts that address this growing field from an interdisciplinary perspective persists. This book presents an overview of new optical communication technologies and a bird's-eye view of some of the more promising technologies among them. The book covers the theoretical but also the practical aspects of technology implementation in a way that is suitable for undergraduate- and graduate-level students, as well as researchers and professional engineers.

Providing straightforward practical guidance, this highly accessible resource presents today's most advanced topics on photonic communications. You get the latest details on 5th generation photonic systems that can be readily applied to your projects in the field. Moreover, the book provides valuable, time-saving tools for network simulation and modeling. You find in-depth coverage of optical signal transmission systems and networks. The book includes coverage of a wide range of critical methods and techniques, such as MIMO (multiple-input and multiple-output), OFDM (Orthogonal frequency-division multiplexing), and advanced modulation and coding. You find detailed discussions on the basic principles and applications of high-speed digital signal processing. Other key topics include advanced concepts on coded-modulation, turbo equalization, polarization-time coding, spatial-domain-based modulation and coding, and multidimensional signaling. This comprehensive book includes a complete set of problems at the end of each chapter to help you master the material.

This book presents advances in the field of optical networks - specifically on research and applications in elastic optical networks (EON). The material reflects the authors' extensive research and industrial activities and includes contributions from preeminent researchers and practitioners in optical networking. The authors discuss the new research and applications that address the issue of increased bandwidth demand due to disruptive, high bandwidth applications, e.g., video and cloud applications. The book also discusses issues with traffic not only increasing but becoming much more dynamic, both in time and direction, and posits immediate, medium, and long-term solutions throughout the text. The book is intended to provide a reference for network architecture and planning, communication systems, and control and management approaches that are expected to steer the evolution of EONs.

Telecommunications have underpinned social interaction and economic activity since the 19th century and have been increasingly reliant on optical fibers since their initial commercial deployment by BT in 1983. Today, mobile phone networks, data centers, and broadband services that facilitate our entertainment, commerce, and increasingly health provision are built on hidden optical fiber networks. However, recently it emerged that the fiber network is beginning to fill up, leading to the talk of a capacity crunch where the capacity still grows but struggles to keep up with the increasing demand. This book, featuring contributions by the suppliers of widely deployed simulation software and academic authors, illustrates the origins of the limited performance of an optical fiber from the engineering, physics, and information theoretic viewpoints. Solutions are then discussed by pioneers in each of the respective fields, with near-term solutions discussed by industrially based authors, and more speculative high-potential solutions discussed by leading academic groups.

This resource provides the latest details on 5th generation photonic systems that can be readily applied to projects in the field. Moreover, the book provides valuable, time-saving tools for network simulation and modeling. It includes coverage of optical signal transmission systems and networks; a wide range of critical methods and techniques, such as MIMO (multiple-input and multiple-output) by employing spatial modes in few-mode and multicore optical fiber; OFDM (orthogonal frequency-division multiplexing) utilized to enhance the spectral efficiency and to enable elastic optical networking schemes; and

advanced modulation and coding schemes to approach the Shannon's channel capacity limit. There are detailed discussions on the basic principles and applications of high-speed digital signal processing, as well as description of the most relevant post-detection compensation techniques.

Advanced optical modulation and multiplexing techniques have become a key ingredient to the design of modern WDM optically routed networks. This book, reviews the generation and detection of multigigabit/second intensity- and phase modulated formats and highlights their resilience to key impairments found in optical networking, such as optical amplifier noise, chromatic dispersion, WDM crosstalk and fiber nonlinearity. A novel multiplexing technique, namely Absolute Polar Duty Cycle Division Multiplexing (AP-DCDM) which is based on the polar signaling and different return to zero (RZ) duty cycles is reported for high speed optical fiber communication systems. Unlike all the other techniques, in AP-DCDM different users share the communication medium to transmit in the same time period and at the same carrier wavelength, but with different duty cycles. The unique duty cycle for each channel helps to regenerate data at the receiver. The book *Optical Fiber and Wireless Communications* provides a platform for practicing researchers, academics, PhD students, and other scientists to review, plan, design, analyze, evaluate, intend, process, and implement diversiform issues of optical fiber and wireless systems and networks, optical technology components, optical signal processing, and security. The 17 chapters of the book demonstrate capabilities and potentialities of optical communication to solve scientific and engineering problems with varied degrees of complexity.

An expert guide to the new and emerging field of broadband circuits for optical fiber communication. This exciting publication makes it easy for readers to enter into and deepen their knowledge of the new and emerging field of broadband circuits for optical fiber communication. The author's selection and organization of material have been developed, tested, and refined from his many industry courses and seminars. Five types of broadband circuits are discussed in detail: * Transimpedance amplifiers * Limiting amplifiers * Automatic gain control (AGC) amplifiers * Lasers drivers * Modulator drivers. Essential background on optical fiber, photodetectors, lasers, modulators, and receiver theory is presented to help readers understand the system environment in which these broadband circuits operate. For each circuit type, the main specifications and their impact on system performance are explained and illustrated with numerical values. Next, the circuit concepts are discussed and illustrated with practical implementations. A broad range of circuits in MESFET, HFET, BJT, HBT, BiCMOS, and CMOS technologies is covered. Emphasis is on circuits for digital, continuous-mode transmission in the 2.5 to 40 Gb/s range, typically used in SONET, SDH, and Gigabit Ethernet applications. Burst-mode circuits for passive optical networks (PON) and analog circuits for hybrid fiber-coax (HFC) cable-TV applications also are discussed. Learning aids are provided throughout the text to help readers grasp and apply difficult concepts and techniques, including: *

Chapter summaries that highlight the key points * Problem-and-answer sections to help readers apply their newknowledge * Research directions that point to exciting new technologicalbreakthroughs on the horizon * Product examples that show the performance of actual broadbandcircuits * Appendices that cover eye diagrams, differential circuits, Sparameters, transistors, and technologies * A bibliography that leads readers to more complete and in-depthtreatment of specialized topics This is a superior learning tool for upper-level undergraduates andgraduate-level students in circuit design and optical fibercommunication. Unlike other texts that concentrate on analogcircuits in general or mostly on optics, this text providesbalanced coverage of electronic, optic, and system issues. Professionals in the fiber optic industry will find it an excellentreference, incorporating the latest technology and discoveries inthe industry.

This book is intended as a graduate/post graduate level textbook for courses on high-speed optical networks as well as computer networks. The ten chapters cover basic principles of the technology as well as latest developments and further discuss network security, survivability, and reliability of optical networks and priority schemes used in wavelength routing. This book also goes on to examine Fiber To The Home (FTTH) standards and their deployment and research issues and includes examples in all the chapters to aid the understanding of problems and solutions. Presents advanced concepts of optical network devices Includes examples and exercises inall the chapters of the book to aid the understanding of basic problems and solutions for undergraduate and postgraduate students Discusses optical ring metropolitan area networks and queuing system and its interconnection with other networks Discusses routing and wavelength assignment Examines restoration schemes in the survivability of optical networks

Detailing a systems approach, *Optical Wireless Communications: System and Channel Modelling with MATLAB®*, is a self-contained volume that concisely and comprehensively covers the theory and technology of optical wireless communications systems (OWC) in a way that is suitable for undergraduate and graduate-level students, as well as researchers and professional engineers. Incorporating MATLAB® throughout, the authors highlight past and current research activities to illustrate optical sources, transmitters, detectors, receivers, and other devices used in optical wireless communications. They also discuss both indoor and outdoor environments, discussing how different factors—including various channel models—affect system performance and mitigation techniques. In addition, this book broadly covers crucial aspects of OWC systems: Fundamental principles of OWC Devices and systems Modulation techniques and schemes (including polarization shift keying) Channel models and system performance analysis Emerging visible light communications Terrestrial free space optics communication Use of infrared in indoor OWC One entire chapter explores the emerging field of visible light communications, and others describe techniques for using theoretical analysis and simulation to mitigate channel impact on system

performance. Additional topics include wavelet denoising, artificial neural networks, and spatial diversity. Content also covers different challenges encountered in OWC, as well as outlining possible solutions and current research trends. A major attraction of the book is the presentation of MATLAB simulations and codes, which enable readers to execute extensive simulations and better understand OWC in general.

Volume IVA is devoted to progress in optical component research and development. Topics include design of optical fiber for a variety of applications, plus new materials for fiber amplifiers, modulators, optical switches, light wave devices, lasers, and high bit-rate electronics. This volume is an excellent companion to Optical Fiber Telecommunications IVB: Systems and Impairments (March 2002, ISBN: 0-12-3951739). - Fourth in a respected and comprehensive series - Authoritative authors from a range of organizations - Suitable for active lightwave R&D designers, developers, purchasers, operators, students, and analysts - Lightwave components reviewed in Volume A -Lightwave systems and impairments reviewed in Volume B - Up-to-the minute coverage

This book presents a descriptive account on various latest advances in the field of optical communication systems. These systems are extremely essential for all types of networks and telecommunications. They comprise of a transmitter which encodes the message into an optical signal, a channel which carries the signal to its destination, and a receiver which reproduces the message from the received optical signal. This book provides updated results on communication systems, with elucidations on their relevance, provided by veteran researchers in this field. It encompasses fundamental concepts of optical and wireless optical communication systems, optical multiplexing and demultiplexing for optical communication systems, optical amplifiers and networks, and network traffic engineering. Lately, wavelength conversion and other advanced signal processing functions have also been studied in detail for optical communications systems. The book emphasizes on wavelength conversion, demultiplexing in the time domain, switching and other optimized functions for optical communications systems. It is primarily aimed at assisting in advancement and research for a wide range of readers including design engineer teams in manufacturing industry, academia and telecommunications service operators/providers.

In order to adapt to the ever-increasing demands of telecommunication needs, today's network operators are implementing 100 Gb/s per dense wavelength division multiplexing (DWDM) channel transmission. At those data rates, the performance of fiberoptic communication systems is degraded significantly due to intra- and inter-channel fiber nonlinearities, polarization-mode dispersion (PMD), and chromatic dispersion. In order to deal with those channel impairments, novel advanced techniques in modulation and detection, coding and signal processing are needed. This unique book represents a coherent and comprehensive introduction to the fundamentals of optical communications, signal processing and coding for optical channels. It is the first to integrate the fundamentals of

coding theory with the fundamentals of optical communication.

Combines theory with real-world case studies to give a comprehensive overview of modern optical wireless technology.

This book explains how optical communication systems are used to provide high-speed communication connections. You will learn basic optical principles including how to create and detect light signals, reflection and refraction, basic lightwave propagation and optical signal processing. Provided is an overview of the components and basic operation of optical systems including synchronous optical network (SONET), synchronous digital hierarchy (SDH), fiber distributed data interface (FDDI), passive optical networks (PON) and dense wave division multiplexing (DWDM). The common types of network equipment such as ONU, ADM, and optical switches are described. Discover how optical transmitters and modulators operate including light emitting diodes (LEDs) and LASERS. The differences between these light sources are explained along with how some types of light sources are better suited to send information over short and long distances. Fiber optic transmission is described including how single mode and multimode optical fibers operate along with their transmission characteristics. You will learn how modal dispersion, material dispersion and cable bending affects the performance and ability of fiber cable to transfer light signals. The methods and devices used to couple light signals into and out of fiber cables are discussed. You will discover how photodetection and optical receivers convert optical signals into electrical signals along with the different types of photodetectors and their ability (sensitivity) to light signals. Explained are the basics of how optical demodulation and demultiplexing are used to receive, separate multiple channels of optical signals. An introduction to testing in optical systems is included. The basic methods of optical fiber testing including continuity testing and measuring optical loss is included. Discover how to use an optical time domain reflectometer (OTDR) to identify the specific locations of breaks or distortions in fiber cable. Learn the basic steps for fiber optic link and system acceptance testing. Troubleshooting processes and tips are included to help you diagnose and repair equipment and link failures along with how to maintain maintenance records.

With optical fiber telecommunications firmly entrenched in the global information infrastructure, a key question for the future is how deeply will optical communications penetrate and complement other forms of communication (e.g., wireless access, on-premises networks, interconnects, and satellites). Optical Fiber Telecommunications, the seventh edition of the classic series that has chronicled the progress in the research and development of lightwave communications since 1979, examines present and future opportunities by presenting the latest advances on key topics such as: Fiber and 5G-wireless access networks Inter- and intra-data center communications Free-space and quantum communication links Another key issue is the use of advanced photonics manufacturing and electronic signal processing to lower the cost of

services and increase the system performance. To address this, the book covers: Foundry and software capabilities for widespread user access to photonic integrated circuits Nano- and microphotonic components Advanced and nonconventional data modulation formats The traditional emphasis of achieving higher data rates and longer transmission distances are also addressed through chapters on space-division-multiplexing, undersea cable systems, and efficient reconfigurable networking. This book is intended as an ideal reference suitable for university and industry researchers, graduate students, optical systems implementers, network operators, managers, and investors. Quotes: "This book series, which owes much of its distinguished history to the late Drs. Kaminow and Li, describes hot and growing applied topics, which include long-distance and wideband systems, data centers, 5G, wireless networks, foundry production of photonic integrated circuits, quantum communications, and AI/deep-learning. These subjects will be highly beneficial for industrial R&D engineers, university teachers and students, and funding agents in the business sector." Prof. Kenichi Iga President (Retired), Tokyo Institute of Technology "With the passing of two luminaries, Ivan Kaminow and Tingye Li, I feared the loss of one of the premier reference books in the field. Happily, this new version comes to chronicle the current state-of-the-art and is written by the next generation of leaders. This is a must-have reference book for anyone working in or trying to understand the field of optical fiber communications technology." Dr. Donald B. Keck Vice President, Corning, Inc. (Retired) "This book is the seventh edition in the definitive series that was previously marshaled by the extraordinary Ivan Kaminow and Tingye Li, both sadly no longer with us. The series has charted the remarkable progress made in the field, and over a billion kilometers of optical fiber currently snake across the globe carrying ever-increasing Internet traffic. Anyone wondering about how we will cope with this incredible growth must read this book." Prof. Sir David Payne Director, Optoelectronics Research Centre, University of Southampton Updated edition presents the latest advances in optical fiber components, systems, subsystems and networks Written by leading authorities from academia and industry Gives a self-contained overview of specific technologies, covering both the state-of-the-art and future research challenges Since the revival of coherent optical communications in 2006, significant progress has been made in the field. For example, spectral efficiency of optical communication systems has been increased from 0.8 b/s/Hz to over 14.0 b/s/Hz in a single mode fiber. This progress is the result of improved technologies such as advanced modulation, digital coherent detection, coding, and digital signal processing. The first part of the book is devoted to advanced modulation, coding, and multiplexing technologies. Various linear and nonlinear impairments and their digital mitigation methods are presented, followed by impairment-tolerant and hardware-efficient symbol and carrier recovery algorithms, plus issues and challenges in real-time implementation of high-speed digital coherent transceivers. The authors reveal important progress in photonic integration and

performance monitoring, and look beyond WDM (wavelength division multiplexing) to space-division-multiplexing (SDM) based technologies, which can improve fiber and network capacity.

This second edition of Digital Optical Communications provides a comprehensive treatment of the modern aspects of coherent homodyne and self-coherent reception techniques using algorithms incorporated in digital signal processing (DSP) systems and DSP-based transmitters to overcome several linear and nonlinear transmission impairments and frequency mismatching between the local oscillator and the carrier, as well as clock recovery and cycle slips. These modern transmission systems have emerged as the core technology for Tera-bits per second (bps) and Peta-bps optical Internet for the near future. Featuring extensive updates to all existing chapters, Advanced Digital Optical Communications, Second Edition: Contains new chapters on optical fiber structures and propagation, optical coherent receivers, DSP equalizer algorithms, and high-order spectral DSP receivers Examines theoretical foundations, practical case studies, and MATLAB® and Simulink® models for simulation transmissions Includes new end-of-chapter practice problems and useful appendices to supplement technical information Downloadable content available with qualifying course adoption Advanced Digital Optical Communications, Second Edition supplies a fundamental understanding of digital communication applications in optical communication technologies, emphasizing operation principles versus heavy mathematical analysis. It is an ideal text for aspiring engineers and a valuable professional reference for those involved in optics, telecommunications, electronics, photonics, and digital signal processing. This book focuses on recent research and developments on optical communications. The chapters present different aspects of optical communication systems, comprising high capacity transmission over long distances, coherent and intensity modulated technologies, orthogonal frequency-division multiplexing, ultrafast switching techniques, and photonic integrated devices. Digital signal processing and error correction techniques are also addressed. The content is of interest to graduate students and researchers in optical communications.

Optical Fiber Telecommunications V (A&B) is the fifth in a series that has chronicled the progress in the research and development of lightwave communications since the early 1970s. Written by active authorities from academia and industry, this edition not only brings a fresh look to many essential topics but also focuses on network management and services. Using high bandwidth in a cost-effective manner for the development of customer applications is a central theme. This book is ideal for R&D engineers and managers, optical systems implementers, university researchers and students, network operators, and the investment community. Volume (A) is devoted to components and subsystems, including: semiconductor lasers, modulators, photodetectors, integrated photonic circuits, photonic crystals, specialty fibers, polarization-mode dispersion, electronic signal processing, MEMS, nonlinear optical signal processing, and quantum information technologies. Volume (B) is devoted to systems and networks, including: advanced modulation formats, coherent systems, time-multiplexed systems,

performance monitoring, reconfigurable add-drop multiplexers, Ethernet technologies, broadband access and services, metro networks, long-haul transmission, optical switching, microwave photonics, computer interconnections, and simulation tools.

Biographical Sketches Ivan Kaminow retired from Bell Labs in 1996 after a 42-year career. He conducted seminal studies on electrooptic modulators and materials, Raman scattering in ferroelectrics, integrated optics, semiconductor lasers (DBR, ridge-waveguide InGaAsP and multi-frequency), birefringent optical fibers, and WDM networks. Later, he led research on WDM components (EDFAs, AWGs and fiber Fabry-Perot Filters), and on WDM local and wide area networks. He is a member of the National Academy of Engineering and a recipient of the IEEE/OSA John Tyndall, OSA Charles Townes and IEEE/LEOS Quantum Electronics Awards. Since 2004, he has been Adjunct Professor of Electrical Engineering at the University of California, Berkeley. Tingye Li retired from AT&T in 1998 after a 41-year career at Bell Labs and AT&T Labs. His seminal work on laser resonator modes is considered a classic. Since the late 1960s, He and his groups have conducted pioneering studies on lightwave technologies and systems. He led the work on amplified WDM transmission systems and championed their deployment for upgrading network capacity. He is a member of the National Academy of Engineering and a foreign member of the Chinese Academy of Engineering. He is a recipient of the IEEE David Sarnoff Award, IEEE/OSA John Tyndall Award, OSA Ives Medal/Quinn Endowment, AT&T Science and Technology Medal, and IEEE Photonics Award. Alan Willner has worked at AT&T Bell Labs and Bellcore, and he is Professor of Electrical Engineering at the University of Southern California. He received the NSF Presidential Faculty Fellows Award from the White House, Packard Foundation Fellowship, NSF National Young Investigator Award, Fulbright Foundation Senior Scholar, IEEE LEOS Distinguished Lecturer, and USC University-Wide Award for Excellence in Teaching. He is a Fellow of IEEE and OSA, and he has been President of the IEEE LEOS, Editor-in-Chief of the IEEE/OSA J. of Lightwave Technology, Editor-in-Chief of Optics Letters, Co-Chair of the OSA Science & Engineering Council, and General Co-Chair of the Conference on Lasers and Electro-Optics.

Our research is focused on theoretical investigations of advanced optical fiber communication systems and can be grouped into three broad areas: WDM networks, coherent analog links, and optical fiber nonlinearities. In the area of WDM networks, we proposed and investigated a novel WDM network architecture (STARNET), a novel combined phase/amplitude modulation format, and a high-speed optics-to-computer interface for STARNET. In the area of coherent analog links, we investigated angle and amplitude modulated systems for linewidth-insensitive analog applications and direct-frequency-modulated subcarrier-multiplexed systems. In the area of fiber nonlinearities, we investigated four-wave mixing, thermally induced parasitic phase modulation, and a new type of soliton.

Carefully structured to provide practical knowledge on fundamental issues, Optical Fiber Communications Systems: Theory and Practice with MATLAB® and Simulink® Models explores advanced modulation and transmission techniques of lightwave communication systems. With coverage ranging from fundamental to modern aspects, the text presents optical communication techniques and applications, employing single mode optical fibers as the transmission medium. With MATLAB and Simulink models

that illustrate methods, it supplies a deeper understanding of future development of optical systems and networks. The book begins with an overview of the development of optical fiber communications technology over the last three decades of the 20th century. It describes the optical transmitters for direct and external modulation technique and discusses the detection of optical signals under direct coherent and incoherent reception. The author also covers lumped Er:doped and distributed Raman optical amplifiers with extensive models for the amplification of signals and structuring the amplifiers on the Simulink platform. He outlines a design strategy for optically amplified transmission systems coupled with MATLAB Simulink models, including dispersion and attenuation budget methodology and simulation techniques. The book concludes with coverage of advanced modulation formats for long haul optical fiber transmission systems with accompanied Simulink models. Although many books have been written on this topic over the last two decades, most of them present only the theory and practice of devices and subsystems of the optical fiber communications systems in the fields, but do not illustrate any computer models to represent the true practical aspects of engineering practice. This book fills the need for a text that emphasizes practical computing models that shed light on the behavior and dynamics of the devices.

The mobile market has experienced unprecedented growth over the last few decades. Consumer trends have shifted towards mobile internet services supported by 3G and 4G networks worldwide. Inherent to existing networks are problems such as lack of spectrum, high energy consumption, and inter-cell interference. These limitations have led to the emergence of 5G technology. It is clear that any 5G system will integrate optical communications, which is already a mainstay of wide area networks. Using an optical core to route 5G data raises significant questions of how wireless and optical can coexist in synergy to provide smooth, end-to-end communication pathways. *Optical and Wireless Convergence for 5G Networks* explores new emerging technologies, concepts, and approaches for seamlessly integrating optical-wireless for 5G and beyond. Considering both fronthaul and backhaul perspectives, this timely book provides insights on managing an ecosystem of mixed and multiple access network communications focused on optical-wireless convergence. Topics include Fiber–Wireless (FiWi), Hybrid Fiber-Wireless (HFW), Visible Light Communication (VLC), 5G optical sensing technologies, approaches to real-time IoT applications, Tactile Internet, Fog Computing (FC), Network Functions Virtualization (NFV), Software-Defined Networking (SDN), and many others. This book aims to provide an inclusive survey of 5G optical-wireless requirements, architecture developments, and technological solutions.

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