

# Physical Principles of Wireless Communications

Second Edition



Victor L. Granatstein



CRC Press  
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# Physical Principles Wireless Communications Edition

**Mailadil T. Sebastian**



## **Physical Principles Wireless Communications Edition:**

Physical Principles of Wireless Communications, 2nd Edition Victor Granatstein, 2012 Updated and expanded Physical Principles of Wireless Communications Second Edition illustrates the relationship between scientific discoveries and their application to the invention and engineering of wireless communication systems The second edition of this popular textbook starts with a review of the relevant physical laws including

**Physical Principles of Wireless Communications, Second Edition** Victor L. Granatstein, 2012-03-26 Updated and expanded Physical Principles of Wireless Communications Second Edition illustrates the relationship between scientific discoveries and their application to the invention and engineering of wireless communication systems The second edition of this popular textbook starts with a review of the relevant physical laws including Planck's Law of Blackbody Radiation Maxwell's equations and the laws of Special and General Relativity It describes sources of electromagnetic noise operation of antennas and antenna arrays propagation losses and satellite operation in sufficient detail to allow students to perform their own system designs and engineering calculations Illustrating the operation of the physical layer of wireless communication systems including cell phones communication satellites and wireless local area networks the text covers the basic equations of electromagnetism the principles of probability theory and the operation of antennas It explores the propagation of electromagnetic waves and describes the losses and interference effects that waves encounter as they propagate through cities inside buildings and to and from satellites orbiting the earth Important natural phenomena are also described including Cosmic Microwave Background Radiation ionospheric reflection and tropospheric refraction New in the Second Edition Descriptions of 3G and 4G cell phone systems Discussions on the relation between the basic laws of quantum and relativistic physics and the engineering of modern wireless communication systems A new section on Planck's Law of Blackbody Radiation Expanded discussions on general relativity and special relativity and their relevance to GPS system design An expanded chapter on antennas that includes wire loop antennas Expanded discussion of shadowing correlations and their effect on cell phone system design The text covers the physics of Geostationary Earth Orbiting satellites Medium Earth Orbiting satellites and Low Earth Orbiting satellites enabling students to evaluate and make first order designs of SATCOM systems It also reviews the principles of probability theory to help them accurately determine the margins that must be allowed to account for statistical variation in path loss The included problem sets and sample solutions provide students with the understanding of contemporary wireless systems needed to participate in the development of future systems

Physical Principles of Wireless Communications Victor L. Granatstein, 2012-03-26 Updated and expanded Physical Principles of Wireless Communications Second Edition illustrates the relationship between scientific discoveries and their application to the invention and engineering of wireless communication systems The second edition of this popular textbook starts with a review of the relevant physical laws including

**Physical Principles of Wireless Communications** Granatstein Victor L Staff, 2008-02-11

**Physical Principles of Wireless Communications**

Victor L. Granatstein, 2007-10-29 Wireless communications are based on the launching propagation and detection of electromagnetic waves emitted primarily at radio or microwave frequencies Their history can be traced back to the mid 19th century when James Clerk Maxwell formulated the basic laws of electromagnetism and Heinrich Hertz demonstrated the propagation of radio waves across his laboratory Recent engineering breakthroughs have led to wireless communication systems that have not only revolutionized modern lifestyles but have also launched new industries Based on the author's course in the physics of wireless communications Physical Principles of Wireless Communications provides students with a solid foundation in modern wireless communication systems It offers rigorous analyses of the devices and physical mechanisms that constitute the physical layers of these systems Starting with a review of Maxwell's equations the textbook details the operation of antennas and antenna arrays teaching students how to perform the necessary design calculations It also explores the propagation of electromagnetic waves leading to important descriptions of mean path loss The text also reviews the principles of probability theory enabling students to calculate the margins that must be allowed to account for statistical variation in path loss In addition it covers the physics of Geostationary Earth Orbiting GEO satellites and Low Earth Orbiting LEO satellites so students may evaluate and make first order designs of satellite communications SATCOM systems

**The Physics and Mathematics of Electromagnetic Wave Propagation in Cellular Wireless Communication** Tapan K. Sarkar, Magdalena Salazar Palma, Mohammad Najib Abdallah, 2018-05-31 An important resource that examines the physical aspects of wireless communications based on mathematical and physical evidence The Physics and Mathematics of Electromagnetic Wave Propagation in Cellular Wireless Communication describes the electromagnetic principles for designing a cellular wireless system and includes the subtle electromagnetic principles that are often overlooked in designing such a system This important text explores both the physics and mathematical concepts used in deploying antennas for transmission and reception of electromagnetic signals and examines how to select the proper methodology from a wide range of scenarios In this much needed guide the authors noted experts in the field explore the principle of electromagnetics as developed through the Maxwellian principles and describe the properties of an antenna in the frequency domain The text also includes a review of the characterization of propagation path loss in a cellular wireless environment and examines ultrawideband antennas and the mechanisms of broadband transmission of both power and information This important resource Includes a discussion of the shortcomings of a MIMO system from both theoretical and practical aspects Demonstrates how to deploy base station antennas with better efficiency Validates the principle and the theoretical analysis of electromagnetic propagation in cellular wireless communication Contains results of experiments that are solidly grounded in mathematics and physics Written for engineers researchers and educators who are or plan to work in the field The Physics and Mathematics of Electromagnetic Wave Propagation in Cellular Wireless Communication offers an essential resource for understanding the principles underpinning wireless communications *Principles of Mobile*

*Communication* Gordon L. Stüber, 2017-05-30 This mathematically rigorous overview of physical layer wireless communications is now in a 4th fully revised and updated edition The new edition features new content on 4G cellular systems 5G cellular outlook bandpass signals and systems and polarization among many other topics in addition to a new chapters on channel assignment techniques Along with coverage of fundamentals and basic principles sufficient for novice students the volume includes finer details that satisfy the requirements of graduate students aiming to conduct in depth research The book begins with a survey of the field introducing issues relevant to wireless communications The book moves on to cover relevant discrete subjects from radio propagation to error probability performance and cellular radio resource management An appendix provides a tutorial on probability and random processes The content stresses core principles that are applicable to a broad range of wireless standards New examples are provided throughout the book to better explain the more complex material to the reader Additional problems have also been added to those already appearing at the ends of the chapters to make the book more suitable for course instruction

**Military Communications in the Future Battlefield** Marko Suojanen, 2018-07-31 Taking an applications oriented view this unique volume delivers a forward looking roadmap to military communications This hands on reference offers military and security technology practitioners insights into the key issues related to long term development within the battlefield communications area The book presents the technological alternatives for communication in the battlefield in unexpected situations and environments This authoritative resource discusses unstructured formations of actors using a holistic approach that considers key capability requirements Professionals and officers learn how to prepare for the unexpected and start building agile adaptive and cognitive systems that are needed in future operating environments From scenario based capability planning to situational and context awareness to unmanned ground and aerial platforms this easy to understand book covers the critical topics that practitioners need to master to achieve top performance in the battlefield

**Reducing Process Costs with Lean, Six Sigma, and Value Engineering Techniques** Kim H. Pries, Jon M. Quigley, 2012-12-13 A company with effective cost reduction activities in place will be better positioned to adapt to shifting economic conditions In fact it can make the difference between organizations that thrive and those that simply survive during times of economic uncertainty Reducing Process Costs with Lean Six Sigma and Value Engineering Techniques covers

*Mobile Ad Hoc Networks* Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, 2016-04-19 Guiding readers through the basics of these rapidly emerging networks to more advanced concepts and future expectations this book examines the most pressing research issues in Mobile Ad hoc Networks MANETs Leading researchers industry professionals and academics provide an authoritative perspective of the state of the art in MANETs The book includes surveys of recent publications that investigate key areas of interest such as limited resources and the mobility of mobile nodes It considers routing multicast energy security channel assignment and ensuring quality of service

*Radiolocation in Ubiquitous Wireless Communication* Danko Antolovic, 2010-01-05

This volume has its beginnings in a laboratory project development of a radio locator for the Wi-Fi network that was growing by leaps and bounds on the campus of Indiana University at that time. What started as a very focused and practical attempt to improve network management touched in its lifetime upon broader issues of the use of radio spectrum design of system architectures for the wireless medium and image formation outside the limits of geometrical optics.

I have intended this book mostly for the audience of engineers and system designers in the growing field of radio communication among small portable ubiquitous devices that have become hybrid platforms for personal communication and personal computing. It is also a book addressed to network professionals, people to whom radio is largely a black box, a medium that they usually rely upon but seldom fully understand. In fact, in the course of my work in the field I have witnessed to my dismay a wide disconnect between the networking world and the radio technology that networking has come to depend upon so heavily. Perhaps because digital wireless communication is seen as digital first and wireless second, there is often a misplaced emphasis on its information processing side with the methodology centered around the discrete symbol and with little intuition of the underlying physics. I had it once suggested to me in apparent seriousness to use radio cards for intra-system communication within a radio locator.

Wireless communication is radio plain and simple. **Ionosphere and Applied Aspects of Radio Communication and Radar** Nathan Blaunstein, Eugeniu Plohotniuc, 2008-05-13 A Complete Reference for the 21st Century. Until recently, much of the communications technology in the former Eastern bloc countries was largely unknown. Due to the historically competitive nature of East-West relations, scientific groups operated independently without the benefit of open communication or theoretical framework. *Satellite Systems Engineering in an IPv6 Environment* Daniel Minoli, 2009-02-03 Capitalize on Expert Foresight into the Future of Satellite Communication. Satellite technology will maintain its key role in the evolving communications needs of government, military, IPTV, and mobile video industries because of its intrinsic multicast, broadcast capabilities, mobility, aspects, global reach, reliability, and ability to quickly support.

**Simplified TRIZ** Kalevi Rantanen, Ellen Domb, 2010-12-12 a practical guide to the application of TRIZ, compact and well written with a number of easily comprehensible examples. It is a very useful addition to the other books on TRIZ. TQM Magazine. This completely revised and updated second edition continues to demystify TRIZ, the internationally acclaimed problem-solving technique. It demonstrates how TRIZ can be used to enhance Six Sigma, CM, SCM, QFD, and Taguchi methods. In addition to numerous exercises, worksheets, and tables that further illustrate the concepts of this multinational method, this indispensable volume presents a new model for problem solving based on four TRIZ tenets: contradiction, resources, ideality, and patterns of evolution, simplified for better understanding and application. Shows you how to maximize your current technology investment by combining technology with TRIZ. Illustrates how both small and large companies are using TRIZ and achieving significant results. Provides clarification of how the patterns of evolution allow not only what-if scenarios but real forecasts with significant accuracy. With the valuable tools described within these pages, you will be able to find

innovative solutions to problems understand the evolution of systems and develop more ideas faster      **Antennas and Propagation for Wireless Communication Systems** Simon R. Saunders,Alejandro A. Aragón-Zavala,2024-11-25

Comprehensive resource describing both fundamentals and practical industry applications of antennas and radio propagation employed in modern wireless communication systems The newly revised and thoroughly updated Third Edition of this classic and popular text Antennas and Propagation for Wireless Communication Systems addresses fundamentals and practical applications of antennas and radio propagation commonly used in modern wireless communication systems from the basic electromagnetic principles to the characteristics of the technology employed in the most recent systems deployed with an outlook of forthcoming developments in the field Core topics include fundamental electromagnetic principles underlying propagation and antennas basic concepts of antennas and their application to specific wireless systems propagation measurement modelling and prediction for fixed links macrocells microcells femtocells picocells and megacells and narrowband and wideband channel modelling and the effect of the channel on communication system performance Worked examples as well as specific assignments for students are presented throughout the text with a solutions manual available for course tutors with a dedicated website containing online calculators and additional resources plus details of simple measurements that students can perform with off the shelf equipment such as their laptops and a Wi Fi card This Third Edition of Antennas and Propagation for Wireless Communication Systems has been thoroughly revised and updated expanding on and adding brand new coverage of sample topics such as Maxwell s equations and EM theory multiple reflections as propagation mechanisms and waveguiding HAPS High Altitude Platforms propagation design and noise considerations of earth stations macrocell models and cellular base station site engineering FSS frequency selective surfaces adaptive antenna theory developments massive and distributed MIMO in particular and how to process raw data related to channel measurements for mobile radio systems The techniques used in mobile systems spanning the latest 4G 5G and 6G technology generations A wider range of frequencies extending from HF VHF and UHF up to the latest millimetre wave and sub terahertz bands With comprehensive coverage of foundational subject matter as well as major recent advancements in the field Antennas and Propagation for Wireless Communication Systems is an essential resource for undergraduate and postgraduate students researchers and industry engineers in related disciplines      **Handbook of Antennas in Wireless Communications**

Lal Chand Godara,2018-10-03 The move toward worldwide wireless communications continues at a remarkable pace and the antenna element of the technology is crucial to its success With contributions from more than 30 international experts the Handbook of Antennas in Wireless Communications brings together all of the latest research and results to provide engineering professionals and students with a one stop reference on the theory technologies and applications for indoor hand held mobile and satellite systems Beginning with an introduction to wireless communications systems it offers an in depth treatment of propagation prediction and fading channels It then explores antenna technology

with discussion of antenna design methods and the various antennas in current use or development for base stations handheld devices satellite communications and shaping beams The discussions then move to smart antennas and phased array technology including details on array theory and beamforming techniques Space diversity direction of arrival estimation source tracking and blind source separation methods are addressed as are the implementation of smart antennas and the results of field trials of systems using smart antennas implemented Finally the hot media topic of the safety of mobile phones receives due attention including details of how the human body interacts with the electromagnetic fields of these devices Its logical development and extensive range of diagrams figures and photographs make this handbook easy to follow and provide a clear understanding of design techniques and the performance of finished products Its unique comprehensive coverage written by top experts in their fields promises to make the Handbook of Antennas in Wireless Communications the standard reference for the field

**Dielectric Materials for Wireless Communication** Mailadil T. Sebastian, 2010-07-07 Microwave dielectric materials play a key role in our global society with a wide range of applications from terrestrial and satellite communication including software radio GPS and DBS TV to environmental monitoring via satellite A small ceramic component made from a dielectric material is fundamental to the operation of filters and oscillators in several microwave systems In microwave communications dielectric resonator filters are used to discriminate between wanted and unwanted signal frequencies in the transmitted and received signal When the wanted frequency is extracted and detected it is necessary to maintain a strong signal For clarity it is also critical that the wanted signal frequencies are not affected by seasonal temperature changes In order to meet the specifications of current and future systems improved or new microwave components based on dedicated dielectric materials and new designs are required The recent progress in microwave telecommunication satellite broadcasting and intelligent transport systems ITS has resulted in an increased demand for Dielectric Resonators DRs With the recent revolution in mobile phone and satellite communication systems using microwaves as the propagation media the research and development in the field of device miniaturization has been a major challenge in contemporary Materials Science In a mobile phone communication the message is sent from a phone to the nearest base station and then on via a series of base stations to the other phone At the heart of each base station is the combiner filter unit which has the job of receiving the messages keeping them separate amplifying the signals and sending them onto the next base station For such a microwave circuit to work part of it needs to resonate at the specific working frequency The frequency determining component resonator used in such a high frequency device must satisfy certain criteria The three important characteristics required for a dielectric resonator are a a high dielectric constant which facilitates miniaturization b a high quality factor  $Q_{xf}$  which improves the signal to noise ratio c a low temperature coefficient of the resonant frequency which determines the stability of the transmitted frequency During the past 25 years scientists the world over have developed a large number of new materials about 3000 or improved the properties of known materials About 5000 papers



have been published and more than 1000 patents filed in the area of dielectric resonators and related technologies. This book brings the data and science of these several useful materials together which will be of immense benefit to researchers and engineers the world over. The topics covered in the book include factors affecting the dielectric properties measurement of dielectric properties important low loss dielectric material systems such as perovskites tungsten bronze type materials materials in BaO TiO<sub>2</sub> system Zr Sn TiO<sub>4</sub> alumina rutile AnBn 1O3n type materials LTCC ceramic polymer composites etc. The book also has a data table listing all reported low loss dielectric materials with properties and references arranged in the order of increasing dielectric constant. Collects together in one source data on all new materials used in wireless communication. Includes tabulated properties of all reported low loss dielectric materials. In depth treatment of dielectric resonator materials.

**Network Design for IP Convergence** Yezid Donoso, 2009-02-23. The emergence of quality of service QoS mechanisms continues to propel the development of real time multimedia services such as VoIP and videoconferencing. However many challenges remain in achieving optimized standardization convergence. Network Design for IP Convergence is a comprehensive global guide to recent advances in IP network implementation. Providing an introduction to basic LAN WAN MAN network design the author covers the latest equipment and architecture addressing QoS policies and integration of services among other topics. The book explains how to integrate the different layers of reference models and various technological platforms to mirror the harmonization that occurs in the real world of carrier networks. It furnishes appropriate designs for traditional and critical services in the LAN and carrier networks both MAN and WAN and it clarifies how a specific layer or technology can cause those services to malfunction. This book lays a foundation for understanding with concepts and applicability of QoS parameters under the multilayer scheme and a solid explanation of service infrastructure. It goes on to describe integration in both real time and not real time elaborating on how both processes can co exist within the same IP network and concluding with the designs and configurations of service connections.

**Learn How to Overcome Obstacles to Improve Technology** This sweeping analysis of the implementation of IP convergence and QoS mechanisms helps designers and operators get past key obstacles such as integrating platform layers and technologies and implementing various associated QoS concepts to improve technology and standards.

**Carrier Ethernet** Gilbert Held, 2008-03-11. Facilitating high data transfers over long distances at a reasonable cost Carrier Ethernet is solidifying its fundamental position as the core of next generation networks. Since it first dazzled the IT world 40 years ago with its ability to move data over local networks Ethernet has dramatically evolved in both form and function. And now Carrier

**IMS** Mark Wuthnow, Jerry Shih, Matthew Stafford, 2009-07-28. IP Multimedia Subsystem IMS technology which merges the Internet with interactive telecommunications represents the here and now for today's packet switched networks. Consequently anyone working with or around these converging fields needs to possess a fundamental understanding of IMS and how this technology is poised to change the way new app

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