

## **Engineering Electromagnetic Fields Johnk**

**This book covers the principles of operation of electromagnetic waveguides and transmission lines. The approach is divided between mathematical descriptions of basic behaviors and treatment of specific types of waveguide structures. Classical (distributed-network) transmission lines, their basic properties, their connection to lumped-element networks, and the distortion of pulses are discussed followed by a full field analysis of waveguide modes. Modes of specific kinds of waveguides - traditional hollow metallic waveguides, dielectric (including optical) waveguides, etc. are discussed. Problems of excitation and scattering of waveguide modes are addressed, followed by discussion of real systems and performance. This book addresses propagation phenomena in satellite, radar, broadcasting, short range , trans-horizon and several recent modes of communications in radio links. Also, it includes some topics on antennas , radio noises and improvement techniques. The book provides the necessary basic matters, as well as experimental results and calculation procedures for radio link design.**

**This book presents a comprehensive treatment of electromagnetic analysis and design of three critical devices for an MRI system - the magnet, gradient coils, and radiofrequency (RF) coils. Electromagnetic Analysis and Design in Magnetic Resonance Imaging is unique in its detailed examination of the analysis and design of the hardware for an MRI system. It takes an engineering perspective to serve the many scientists and engineers in this rapidly expanding field. Chapters present: an introduction to MRI basic concepts of electromagnetics, including Helmholtz and Maxwell coils, inductance calculation, and magnetic fields produced by special cylindrical and spherical surface currents principles for the analysis and design of gradient coils, including discrete wires and the target field method analysis of RF coils based on the equivalent lumped-circuit model as well as an analysis based on the integral equation formulation survey of special purpose RF coils analytical and numerical methods for the analysis of electromagnetic fields in biological objects With the continued, active development of MRI instrumentation, Electromagnetic Analysis and Design in Magnetic Resonance Imaging presents an excellent, logically organized text - an indispensable resource for engineers, physicists, and graduate students working in the field of MRI.**

**Loop and Partial  
Electromagnetic Shielding**

## **Radiation Nation**

### **Electromagnetic Metrology**

### **Inverse Problems in Electric Circuits and Electromagnetics**

A clearly written introduction to the key physical and engineering principles of electromagnetics, first published in 2000.

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.**

**The Electrical Engineer's Handbook is an invaluable reference source for all practicing electrical engineers and students. Encompassing 79 chapters, this book is intended to enlighten and refresh knowledge of the practicing engineer or to help educate engineering students. This text will most likely be the engineer's first choice in looking for a solution; extensive, complete references to other sources are provided throughout. No other book has the breadth and depth of coverage available here. This is a must-have for all practitioners and students! The Electrical Engineer's Handbook provides the most up-to-date information in: Circuits and Networks, Electric Power Systems, Electronics, Computer-Aided Design and Optimization, VLSI Systems, Signal Processing, Digital Systems and Computer Engineering, Digital Communication and Communication Networks, Electromagnetics and Control and Systems. About the Editor-in-Chief... Wai-Kai Chen is Professor and Head Emeritus of the Department of Electrical Engineering and Computer Science at the University of Illinois at Chicago. He has extensive experience in education and industry and is very active professionally in the fields of circuits and systems. He was Editor-in-Chief of the IEEE Transactions on Circuits and Systems, Series I and II, President of the IEEE Circuits and Systems Society and is the Founding Editor and Editor-in-Chief of the Journal of Circuits, Systems and Computers. He is the recipient of the Golden Jubilee Medal, the Education Award, and the Meritorious Service Award from the IEEE Circuits and Systems Society, and the Third Millennium Medal from the IEEE. Professor Chen is a fellow of the IEEE and the American Association for the Advancement of Science. \* 77 chapters encompass the entire field of electrical engineering. \* THOUSANDS of valuable figures, tables, formulas, and definitions. \* Extensive bibliographic references.**

**Field Theory Concepts**

**Physics and Mathematics of MEG and EEG**

## Electromagnetic Fields

Electromagnetic Fields. Maxwell's Equations grad, curl, div. etc. Finite-Element Method. Finite-Difference Method. Charge Simulation Method. Monte Carlo Method

## Engineering Electromagnetic Fields and Waves

*In this book, original and comprehensive studies discuss shielding effectiveness as related to conductivity, and the relationship of material chemistry to conductivity and corrosion are demonstrated. It is explained how to optimize shielding effectiveness for aircraft and other vehicles. Electrically conductive corrosion prevention materials capable of maintaining EMI/EMP protection of aircraft and weapon systems are identified.*

*Learn to solve both simple and complex electromagnetic problems with this text's unique integration of theoretical and mathematical concepts. With the author's guidance, you'll discover a broad range of classic and cutting-edge applications across a wide array of fields, including biomedicine, wireless communication, process control, and instrumentation. Case studies, detailed derivations, and 170 fully solved examples deepen your understanding of theory, and help you apply numerical methods to real-world problems.*

*Providing an ideal transition from introductory to advanced concepts, Electromagnetics, Second Edition builds a foundation that allows electrical engineers to confidently proceed with the development of advanced EM studies, research, and applications. This second edition of a popular text continues to offer coverage that spans the entire field, from electrostatics to the integral solutions of Maxwell's equations. The book provides a firm grounding in the fundamental concepts of electromagnetics and bolsters understanding through the use of classic examples in shielding, transmission lines, waveguides, propagation through various media, radiation, antennas, and scattering. Mathematical appendices present helpful background information in the areas of Fourier transforms, dyadics, and boundary value problems. The second edition adds a new and extensive chapter on integral equation methods with applications to guided waves, antennas, and scattering. Utilizing the engaging style that made the first edition so appealing, this second edition continues to emphasize the most enduring and research-critical electromagnetic principles.*

## Antenna Theory and Practice

## Electromagnetics, Second Edition

## Proceedings of EHE'07

## Electromagnetic Shielding and Corrosion Protection for Aerospace Vehicles

## Brain Signals

The only resource devoted Solely to Inductance Inductance is an unprecedented text, thoroughly discussing "loop" inductance as well as the increasingly important "partial" inductance. These concepts and their proper calculation are crucial in designing modern high-speed digital systems. World-renowned leader in electromagnetics Clayton Paul provides the knowledge and tools

necessary to understand and calculate inductance. Unlike other texts, Inductance provides all the details about the derivations of the inductances of various inductors, as well as: Fills the need for practical knowledge of partial inductance, which is essential to the prediction of power rail collapse and ground bounce problems in high-speed digital systems Provides a needed refresher on the topics of magnetic fields Addresses a missing link: the calculation of the values of the various physical constructions of inductors—both intentional inductors and unintentional inductors—from basic electromagnetic principles and laws Features the detailed derivation of the loop and partial inductances of numerous configurations of current-carrying conductors With the present and increasing emphasis on high-speed digital systems and high-frequency analog systems, it is imperative that system designers develop an intimate understanding of the concepts and methods in this book. Inductance is a much-needed textbook designed for senior and graduate-level engineering students, as well as a hands-on guide for working engineers and professionals engaged in the design of high-speed digital and high-frequency analog systems.

"A comprehensive and self-contained exposition of the theory and methods used in the analysis and design of permanent magnet and electromechanical devices."--Back cover.

A unified treatment of the generation and analysis of brain-generated electromagnetic fields. In *Brain Signals*, Risto Ilmoniemi and Jukka Sarvas present the basic physical and mathematical principles of magnetoencephalography (MEG) and electroencephalography (EEG), describing what kind of information is available in the neuroelectromagnetic field and how the measured MEG and EEG signals can be analyzed. Unlike most previous works on these topics, which have been collections of writings by different authors using different conventions, this book presents the material in a unified manner, providing the reader with a thorough understanding of basic principles and a firm basis for analyzing data generated by MEG and EEG. The book first provides a brief introduction to brain states and the early history of EEG and MEG, describes the generation of electromagnetic fields by neuronal activity, and discusses the electromagnetic forward problem. The authors then turn to EEG and MEG analysis, offering a review of linear and matrix algebra and basic statistics needed for analysis of the data, and presenting several analysis methods: dipole fitting; the minimum norm estimate (MNE); beamforming; the multiple signal classification algorithm (MUSIC), including RAP-MUSIC with the RAP dilemma and TRAP-MUSIC, which removes the RAP dilemma; independent component analysis (ICA); and blind source separation (BSS) with joint diagonalization.

Engineering Electromagnetics

Theory of Waveguides and Transmission Lines

Electromagnetic Fields and Waves

Electromagnetic Engineering and Waves

2-D Electromagnetic Simulation of Passive Microstrip Circuits

Of the research areas devoted to biomedical sciences, the study of the brain remains a field that continually attracts interest due to the vast range of people afflicted with debilitating brain disorders and those interested in ameliorating its effects. To discover the roots of maladies and grasp the dynamics of brain functions, researchers and practitioners often turn to a process known as brain source localization, which assists in determining the source of

electromagnetic signals from the brain. Aiming to promote both treatments and understanding of brain ailments, ranging from epilepsy and depression to schizophrenia and Parkinson ' s disease, the authors of this book provide a comprehensive account of current developments in the use of neuroimaging techniques for brain analysis. Their book addresses a wide array of topics, including EEG forward and inverse problems, the application of classical MNE, LORETA, Bayesian based MSP, and its modified version, M-MSP. Within the ten chapters that comprise this book, clinicians, researchers, and field experts concerned with the state of brain source localization will find a store of information that can assist them in the quest to enhance the quality of life for people living with brain disorders.

The study of electromagnetic field theory is required for proper understanding of every device wherein electricity is used for operation. The proposed textbook on electromagnetic fields covers all the generic and unconventional topics including electrostatic boundary value problems involving two- and three-dimensional Laplacian fields and one- and two- dimensional Poissonion fields, magnetostatic boundary value problems, eddy currents, and electromagnetic compatibility. The subject matter is supported by practical applications, illustrations to supplement the theory, solved numerical problems, solutions manual and Powerpoint slides including appendices and mathematical relations. Aimed at undergraduate, senior undergraduate students of electrical and electronics engineering, it: Presents fundamental concepts of electromagnetic fields in a simplified manner Covers one two- and three-dimensional electrostatic boundary value problems involving Laplacian fields and Poissonion fields Includes exclusive chapters on eddy currents and electromagnetic compatibility Discusses important aspects of magneto static boundary value problems Explores all the basic vector algebra and vector calculus along with couple of two- and three-dimensional problems This book describes and provides design guidelines for antennas that achieve compactness by using the slot radiator as the fundamental building block within a periodic array, rather than a phased array. It provides the basic electromagnetic tools required to design and analyse these novel antennas, with sample calculations where relevant. The book presents a focused introduction and valuable insights into the relevant antenna technology, together with an overview of the main directions in the evolving technology of compact planar arrays. While the book discusses the historical evolution of compact array antennas, its main focus is on summarising the extensive body of literature on compact antennas. With regard to the now ubiquitous slot radiator, it seeks to demonstrate how, despite significant antenna size reductions that at times even seem to defy the laws of physics, desirable radiation pattern properties can be preserved. This is supported by an examination of recent advances in frequency selective surfaces and in metamaterials, which can, if handled correctly, be used to facilitate physics-defying designs. The book offers a valuable source of information for communication systems and antenna design engineers, especially thanks to its overview of trends in compact planar arrays, yet will also be of interest to students and researchers, as it provides a focused introduction and insights into this highly relevant antenna technology.

Fundamentals of Nuclear Science and Engineering Second Edition

A Technology for Sustainability

From Biomedical Sciences to Wireless Communication

Materials, Analysis, and Applications

Theory and Applications

The foundation for understanding the function and dynamics of biological systems is not only knowledge of their structure, but the new methodologies and applications used to determine that structure. This volume in Biological Magnetic Resonance emphasizes the methods that involve Ultra High Field Magnetic Resonance Imaging. It will interest researchers working in the field of imaging.

This text seeks to illuminate, mainly for the electrical power engineers of the future, the topic of large scale solar flux gathering schemes, which arguably represent the major source of renewable power available. The aim of the content is to impart, from an electromagnetic perspective, a deep and sound understanding of the topic of solar flux collection, ranging from the characteristics of light to the properties of antennas. To do this five chapters are employed to provide a thorough grounding in relevant aspects of electromagnetism and electromagnetic waves including optics, electromagnetic radiation and reception, aperture antennas and array antennas and the quantum electrodynamics aspects of optical absorption, as it relates to photovoltaic techniques. The principles developed in these chapters are then used to underpin and elucidate the main chapters on photovoltaic collectors, concentrated solar power collectors, satellite based collection systems and optical antennas. To establish the novel and transformative renewable technologies, which civilisation will soon require, in order to achieve sustainability quickly and effectively, the availability of professional engineers and scientists with a thorough and commanding grasp of the fundamental science is an absolutely essential prerequisite. This book provides this for solar power generating systems.

Since the publication of the bestselling first edition, there have been numerous advances in the field of nuclear science. In medicine, accelerator based teletherapy and electron-beam therapy have become standard. New demands in national security have stimulated major advances in nuclear instrumentation. An ideal introduction to the fundamentals of nuclear science and engineering, this book presents the basic nuclear science needed to understand and quantify an extensive range of nuclear phenomena. New to the Second Edition— A chapter on radiation detection by Douglas McGregor Up-to-date coverage of radiation hazards, reactor designs, and medical applications Flexible organization of material that allows for quick reference This edition also takes an

in-depth look at particle accelerators, nuclear fusion reactions and devices, and nuclear technology in medical diagnostics and treatment. In addition, the author discusses applications such as the direct conversion of nuclear energy into electricity. The breadth of coverage is unparalleled, ranging from the theory and design characteristics of nuclear reactors to the identification of biological risks associated with ionizing radiation. All topics are supplemented with extensive nuclear data compilations to perform a wealth of calculations. Providing extensive coverage of physics, nuclear science, and nuclear technology of all types, this up-to-date second edition of Fundamentals of Nuclear Science and Engineering is a key reference for any physicists or engineer.

Practical Electromagnetics

Ultra High Field Magnetic Resonance Imaging

Essentials of Electromagnetics for Engineering

Inductance

Electromagnetic Field, Health and Environment

*"Field Theory Concepts" is a new approach to the teaching and understanding of field theory. Exploiting formal analogies of electric, magnetic, and conduction fields and introducing generic concepts results in a transparently structured electromagnetic field theory. Highly illustrative terms allow easy access to the concepts of curl and div which generally are conceptually demanding. Emphasis is placed on the static, quasistatic and dynamic nature of fields. Eventually, numerical field calculation algorithms, e.g. Finite Element method and Monte Carlo method, are presented in a concise yet illustrative manner.*

*This book covers the basic principles for understanding radio wave propagation for common frequency bands used in radio-communications. This includes achievements and developments in propagation models for wireless communication. This book is intended to bridge the gap between the theoretical calculations and approaches to the applied procedures needed for radio links design in a proper manner. The authors emphasize propagation engineering by giving fundamental information and explain the use of basic principles together with technical achievements. This new edition includes additional information on radio wave propagation in guided media and technical issues for fiber optics cable networks with several examples and problems. This book also includes a solution manual - with 90 solved*

*examples distributed throughout the chapters – and 158 problems including practical values and assumptions.*

*Discusses the hidden dangers and health concerns of electromagnetic frequency radiation that is emitted from technological devices that we use everyday and offers practical advice on how to protect yourself and your loved ones from harm.*

*The Physics and Mathematics of Electromagnetic Wave Propagation in Cellular Wireless Communication*

*Electromagnetic Analysis and Design in Magnetic Resonance Imaging*

*The Fallout of Modern Technology*

*Propagation Engineering in Wireless Communications*

*Electromagnetics*

Global Demand for Streamlined Design and Computation The explosion of wireless communications has generated a tidal wave of interest and development in computational techniques for electromagnetic simulation as well as the design and analysis of RF and microwave circuits. Learn About Emerging Disciplines, State-of-the-Art Methods 2-D Electromagnetic Simulation of Passive Microstrip Circuits describes this simple procedure in order to provide basic knowledge and practical insight into quotidian problems of microstrip passive circuits applied to microwave systems and digital technologies. The text dissects the latest emerging disciplines and methods of microwave circuit analysis, carefully balancing theory and state-of-the-art experimental concepts to elucidate the process of analyzing high-speed circuits. The author covers the newer techniques – such as the study of signal integrity within circuits, and the use of field map interpretations – employed in powerful electromagnetic simulation analysis methods. But why and how does the intrinsic two-dimensional simulation model used here reduce numerical error? Step-by-Step Simulation Provides Insight and Understanding The author presents the FDTD electromagnetic simulation method, used to reproduce different microstrip test circuits, as well as an explanation of the complementary electrostatic method of moments (MoM). Each reproduces different microstrip test circuits that are physically constructed and then studied, using a natural methodological progression to facilitate understanding. This approach gives readers a solid comprehension and insight into the theory and practical applications of the microstrip scenario, with emphasis on high-speed interconnection elements.

This Book Has Been Designed For Both The Undergraduate And Postgraduate In Electronic Engineering, Electrical Communication Engineering And Electrical Engineering, And For The Postgraduate In Physics Specialising In Electronics. It Is A Compact And Comprehensive Text And It Stresses The Basic Principles Of Antenna Theory And Practice. Starting With Electromagnetics And The Theory Of Radiation Which Forms The Basis Of Antenna Theory, It Treats In Detail Different Types Of Antennas Like The Linear Antenna, The Cylindrical Antenna, The Biconical Antenna, The Loop Antenna, The Helical Antenna, Slot

And Microstrip Antennas, Horn Antennas, Reflector Antennas, Lens Antennas, Leaky Wave And Surface-Wave Antennas Including Dielectric And Dielectric Loaded Antennas, Wide Band Antennas And Some Modern Special Types Of Antennas. There Are Also Chapters On Antenna Synthesis, Antenna Practice, Antenna Measurements And Electromagnetic Wave Propagation. The Detailed Coverage Of Electromagnetic Theory Enables The Student To Understand The Theoretical Aspects With Comparative Ease. The Chapters On Antenna Synthesis, Antenna Practice And Antenna Measurements Are Useful For The Practical Antenna Engineer. The Problems At The End Of Chapters, Tables And Numerous Illustrations Add To The Value Of The Text. In This Second Edition A New Chapter On Antenna Impedance And Some Solved Problems Have Been Added. The Book Presupposes Only The Knowledge Of Mathematics Which A Student Of Undergraduate Engineering Or Undergraduate Physics Has Required.

"Engineering Electromagnetics and Waves" is designed for upper-division college and university engineering students, for those who wish to learn the subject through self-study, and for practicing engineers who need an up-to-date reference text. The student using this text is assumed to have completed typical lower-division courses in physics and mathematics as well as a first course on electrical engineering circuits." "This book provides engineering students with a solid grasp of electromagnetic fundamentals and electromagnetic waves by emphasizing physical understanding and practical applications. The topical organization of the text starts with an initial exposure to transmission lines and transients on high-speed distributed circuits, naturally bridging electrical circuits and electromagnetics. Teaching and Learning Experience This program will provide a better teaching and learning experience-for you and your students. It provides: Modern Chapter Organization Emphasis on Physical Understanding Detailed Examples, Selected Application Examples, and Abundant Illustrations Numerous End-of-chapter Problems, Emphasizing Selected Practical Applications Historical Notes on the Great Scientific Pioneers Emphasis on Clarity without Sacrificing Rigor and Completeness Hundreds of Footnotes Providing Physical Insight, Leads for Further Reading, and Discussion of Subtle and Interesting Concepts and Applications"

Advanced Engineering Electromagnetics

The Electrical Engineering Handbook

Engineering Electromagnetic and Waves

Manual Engineering Electromagnetic Fields and Wave S

Brain Source Localization Using EEG Signal Analysis

Electromagnetic Field, Health and Environment mirrors the image of the EHE ' 07 conference which attracted people investigating the phenomenon of interaction of electromagnetic field and biological objects. This book tries to enlighten the problem with the use of scientifically founded facts kept within methodological discipline. The particular targets of the book can be briefly summarized as reviewing, presenting and discussing innovations in computer modeling, measurement and simulation of bioelectromagnetic phenomena, analyzing physical and biological aspects of bioelectromagnetic phenomena, and discussing environmental safety and

policy issues as well as relevant international standards. The book is divided into five chapters of which the first three chapters deal with the electromagnetic field in combination with environment, health and biology respectively. The fourth chapter focuses on computer simulation in bioelectromagnetics, whereas the fifth chapter sees to the electromagnetic field in policy and standards. An additional three contributions are included: the first contribution shows the brief essay on Heinrich Rudolf Hertz in which the occasion of his birth 150 years ago is celebrated. The second summarizes the long-lasting research in magnetic stimulation and bioimaging and the third one considers some theoretical aspects of electromagnetic field.

This is the first book to offer a comprehensive exploration of new methods in inverse problems in electromagnetics. The book provides systematic descriptions of the most important practical inverse problems, and details new methods to solve them. Also included are descriptions of the properties of inverse problems and known solutions, as well as reviews of the practical implementation of these methods in electric circuit theory and electromagnetic fields theory. This comprehensive collection of modern theoretical ideas and methods to solve inverse problems will be of value to both students and working professionals.

The definitive reference on electromagnetic shielding materials, configurations, approaches, and analyses This reference provides a comprehensive survey of options for the reduction of the electromagnetic field levels in prescribed areas. After an introduction and an overview of available materials, it discusses figures of merit for shielding configurations, the shielding effectiveness of stratified media, numerical methods for shielding analyses, apertures in planar metal screens, enclosures, and cable shielding. Up to date and comprehensive, Electromagnetic Shielding: Explores new and innovative techniques in electromagnetic shielding Presents a critical approach to electromagnetic shielding that highlights the limits of formulations based on plane-wave sources Analyzes aspects not normally considered in electromagnetic shielding, such as the effects of the content of the shielding enclosures Includes references at the end of each chapter to facilitate further study The last three chapters discuss frequency-selective shielding, shielding design procedures, and uncommon ways of shielding—areas ripe for further research. This is an authoritative, hands-on resource for practicing telecommunications and electrical engineers, as well as researchers in industry and academia who are involved in the design and analysis of electromagnetic shielding structures.

Electromagnetic Foundations of Solar Radiation Collection

Compact Slot Array Antennas for Wireless Communications

Permanent Magnet and Electromechanical Devices

Engineering Electromagnetic Fields and Waves

Propagation Engineering in Radio Links Design

This is a textbook on electromagnetic fields and waves completely based on conceptual understanding of electromagnetics. The text provides operational knowledge and firm grasp of electromagnetic fundamentals aimed toward practical engineering applications by combining fundamental

theory and a unique and comprehensive collection of as many as 888 conceptual questions and problems in electromagnetics. Conceptual questions are designed to strongly enforce and enhance both the theoretical concepts and understanding and problem-solving techniques and skills in electromagnetics.

Balanis' second edition of *Advanced Engineering Electromagnetics* — a global best-seller for over 20 years — covers the advanced knowledge engineers involved in electromagnetic need to know, particularly as the topic relates to the fast-moving, continually evolving, and rapidly expanding field of wireless communications. The immense interest in wireless communications and the expected increase in wireless communications systems projects (antenna, microwave and wireless communication) points to an increase in the number of engineers needed to specialize in this field. In addition, the Instructor Book Companion Site contains a rich collection of multimedia resources for use with this text. Resources include: Ready-made lecture notes in Power Point format for all the chapters. Forty-nine MATLAB® programs to compute, plot and animate some of the wave phenomena Nearly 600 end-of-chapter problems, that's an average of 40 problems per chapter (200 new problems; 50% more than in the first edition) A thoroughly updated Solutions Manual 2500 slides for Instructors are included.

Conceptual Electromagnetics

Introduction to Electromagnetic Fields