

Electromagnetism For Electronic Engineers

This book introduces the fundamentals of geometric algebra and calculus, and applies those tools to the study of electromagnetism. Geometric algebra provides a structure that can represent oriented point, line, plane, and volume segments. Vectors, which can be thought of as a representation of oriented line segments, are generalized to multivectors. A full fledged, but non-commutative (i.e. order matters) multiplication operation will be defined for products of vectors. Namely, the square of a vector is the square of its length. This simple rule, along with a requirement that we can sum vectors and their products, essentially defines geometric algebra. Such sums of scalars, vectors and vector products are called multivectors. The reader will see that familiar concepts such as the dot and cross product are related to a more general vector product, and that algebraic structures such as complex numbers can be represented as multivectors. We will be able to utilize generalized complex exponentials to do rotations in arbitrarily oriented planes in space, and will find that simple geometric algebra representations of many geometric transformations are possible. Generalizations of the divergence and Stokes'

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theorems are required once we choose to work with multivector functions. There is an unfortunate learning curve required to express this generalization, but once overcome, we will be left with a single powerful multivector integration theorem that has no analogue in conventional vector calculus. This fundamental theorem of geometric calculus incorporates Green's (area) theorem, the divergence theorem, Stokes' theorems, and complex residue calculus. Multivector calculus also provides the opportunity to define a few unique and powerful Green's functions that almost trivialize solutions of Maxwell's equations. Instead of working separately with electric and magnetic fields, we will work with a hybrid multivector field that includes both electric and magnetic field contributions, and with a multivector current that includes both charge and current densities. The natural representation of Maxwell's equations is a single multivector equation that is easier to solve and manipulate than the conventional mess of divergence and curl equations are familiar to the reader. This book is aimed at graduate or advanced undergraduates in electrical engineering or physics. While all the fundamental results of electromagnetism are derived from Maxwell's equations, there will be no attempt to motivate Maxwell's equations themselves, so existing familiarity with the subject is desirable.

This comprehensive textbook will help readers to

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acquire a thorough understanding of the fundamentals of electromagnetism and its applications in various areas including spectroscopy, signal processing and contemporary computation. The text introduces the principals and applications of electricity, magnetism and electromagnetic theory which is foundation for communication systems, spectroscopy, and modern computing. It is followed by discussing the digital systems and their importance in computing, difference between digital signal transmission and wireless media, visualization techniques and useful simulation and computational techniques, besides advances in quantum computing. Aimed at senior undergraduate and graduate students in the field of electrical engineering, electronics and communication engineering, this textbook: Provides fundamentals of electromagnetism and its applications in a single volume. Covers recent developments in computing and artificial intelligence. Discussion digital signal processing and wireless communication in depth. Covers advanced applications of electromagnetism in communication, spectroscopy, and computing. Discusses Computer Modelling & Simulation, Artificial Intelligence, and Quantum Computing. This book is an electromagnetics classic. Originally published in 1941, it has been used by many generations of students, teachers, and researchers ever since. Since it is classic electromagnetics,

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every chapter continues to be referenced to this day. This classic reissue contains the entire, original edition first published in 1941. Additionally, two new forewords by Dr. Paul E. Gray (former MIT President and colleague of Dr. Stratton) and another by Dr. Donald G. Dudley, Editor of the IEEE Press Series on E/M Waves on the significance of the book's contribution to the field of Electromagnetics.

The aim of the book and its associated computer disk is to explain the physical nature of electric and magnetic fields encountered in electrical engineering. Field problems are inherently difficult because fields are distributed in space and can exist in what is usually regarded as empty space devoid of matter. The customary approach to fields problems is through algebraic methods and the solution of equations. The book emphasizes instead a method based on geometry which enables the student to visualize the fields. Backed by a computer program (available to download at the bottom of this page) giving visual displays, the method enables the student to attempt real problems and to use design methods. A comprehensive survey of numerical and analytical methods is provided and examples of engineering applications are discussed.

Modern technology is rapidly developing and for this reason future engineers need to acquire advanced knowledge in science and technology, including electromagnetic phenomena. This book is a

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contemporary text of a one-semester course for junior electrical engineering students. It covers a broad spectrum of electromagnetic phenomena such as, surface waves, plasmas, photonic crystals, negative refraction as well as related materials including superconductors. In addition, the text brings together electromagnetism and optics as the majority of texts discuss electromagnetism disconnected from optics. In contrast, in this book both are discussed. Seven labs have been developed to accompany the material of the book. Electromagnetics for Electrical Machines offers a comprehensive yet accessible treatment of the linear theory of electromagnetics and its application to the design of electrical machines. Leveraging valuable classroom insight gained by the authors during their impressive and ongoing teaching careers, this text emphasizes concepts rather than numerical methods, providing presentation/project problems at the end of each chapter to enhance subject knowledge. Highlighting the essence of electromagnetic field (EMF) theory and its correlation with electrical machines, this book: Reviews Maxwell's equations and scalar and vector potentials Describes the special cases leading to the Laplace, Poisson's, eddy current, and wave equations Explores the utility of the uniqueness, generalized Poynting, Helmholtz, and approximation theorems Discusses the Schwarz–Christoffel

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transformation, as well as the determination of airgap permeance Addresses the skin effects in circular conductors and eddy currents in solid and laminated iron cores Contains examples relating to the slot leakage inductance of rotating electrical machines, transformer leakage inductance, and theory of hysteresis machines Presents analyses of EMFs in laminated-rotor induction machines, three-dimensional field analyses for three-phase solid rotor induction machines, and more Electromagnetics for Electrical Machines makes an ideal text for postgraduate-level students of electrical engineering, as well as of physics and electronics and communication engineering. It is also a useful reference for research scholars concerned with problems involving electromagnetics.

Applied Electromagnetics and Electromagnetic Compatibility deals with Radio Frequency Interference (RFI), which is the reception of undesired radio signals originating from digital electronics and electronic equipment. With today's rapid development of radio communication, these undesired signals as well as signals due to natural phenomena such as lightning, sparking, and others are becoming increasingly important in the general area of Electro Magnetic Compatibility (EMC). EMC can be defined as the capability of some electronic equipment or system to be operated at desired levels of performance in a given electromagnetic

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environment without generating EM emissions unacceptable to other systems operating in the vicinity.

The applications of electromagnetic phenomena within electrical engineering have been evolving and progressing at a fast pace. In contrast, the underlying principles have been stable for a long time and are not expected to undergo any changes. It is these electromagnetic field fundamentals that are the subject of discussion in this book with an emphasis on basic principles, concepts and governing laws that apply across the electrical engineering discipline. *Electromagnetic Foundations of Electrical Engineering* begins with an explanation of Maxwell's equations, from which the fundamental laws and principles governing the static and time-varying electric and magnetic fields are derived. Results for both slowly- and rapidly-varying electromagnetic field problems are discussed in detail. Key aspects: Offers a project portfolio, with detailed solutions included on the companion website, which draws together aspects from various chapters so as to ensure comprehensive understanding of the fundamentals. Provides end-of-chapter homework problems with a focus on engineering applications. Progresses chapter by chapter to increasingly more challenging topics, allowing the reader to grasp the more simple phenomena and build upon these foundations.

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Enables the reader to attain a level of competence to subsequently progress to more advanced topics such as electrical machines, power system analysis, electromagnetic compatibility, microwaves and radiation. This book is aimed at electrical engineering students and faculty staff in sub-disciplines as diverse as power and energy systems, circuit theory and telecommunications. It will also appeal to existing electrical engineering professionals with a need for a refresher course in electromagnetic foundations.

Co-authored by an international research group with a long-standing cooperation, this book focuses on engineering-oriented electromagnetic and thermal field modeling and application. It presents important contributions, including advanced and efficient finite element analysis used in the solution of electromagnetic and thermal field problems for large and multi-scale engineering applications involving application script development; magnetic measurement of both magnetic materials and components under various, even extreme conditions, based on well-established (standard and non-standard) experimental systems; and multi-level validation based on both industrial test systems and extended TEAM P21 benchmarking platform. Although these are challenging topics, they are useful for readers from both academia and industry. This book provides students with a thorough

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theoretical understanding of electromagnetic field equations and it also treats a large number of applications. The text is a comprehensive two-semester textbook. The work treats most topics in two steps – a short, introductory chapter followed by a second chapter with in-depth extensive treatment; between 10 to 30 applications per topic; examples and exercises throughout the book; experiments, problems and summaries. The new edition includes: modifications to about 30-40% of the end of chapter problems; a new introduction to electromagnetics based on behavior of charges; a new section on units; MATLAB tools for solution of problems and demonstration of subjects; most chapters include a summary. The book is an undergraduate textbook at the Junior level, intended for required classes in electromagnetics. It is written in simple terms with all details of derivations included and all steps in solutions listed. It requires little beyond basic calculus and can be used for self-study. The wealth of examples and alternative explanations makes it very approachable by students. More than 400 examples and exercises, exercising every topic in the book Includes 600 end-of-chapter problems, many of them applications or simplified applications Discusses the finite element, finite difference and method of moments in a dedicated chapter Based on familiar circuit theory and basic physics, this book serves as an invaluable reference for both

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analog and digital engineers alike. For those who work with analog RF, this book is a must-have resource. With computers and networking equipment of the 21st century running at such high frequencies, it is now crucial for digital designers to understand electromagnetic fields, radiation and transmission lines. This knowledge is necessary for maintaining signal integrity and achieving EMC compliance. Since many digital designers are lacking in analog design skills, let alone electromagnetics, an easy-to-read but informative book on electromagnetic topics should be considered a welcome addition to their professional libraries. Covers topics using conceptual explanations and over 150 lucid figures, in place of complex mathematics Demystifies antennas, waveguides, and transmission line phenomena Provides the foundation necessary to thoroughly understand signal integrity issues associated with high-speed digital design This study of electromagnetic theory introduces students to a broad range of quantities and concepts, imparting the necessary vector analysis and associated mathematics and reinforcing its teachings with several elementary field problems. Based on circuit theory rather than on the classical force-relationship approach, the text uses the theory of electric circuits to provide a system of experiments already familiar to the electrical engineer; a series of field concepts are then introduced as a logical

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extension of circuit theory. Virtually unobtainable elsewhere, this text was written by a prominent professor whose recognition includes the prestigious IEEE Electromagnetics Award. It is appropriate for advanced undergraduate and graduate students with a background in calculus and circuit theory. 176 Figures. 9 Tables.

This is a fully revised and updated edition of a widely used introductory textbook on electromagnetism. It covers all the fundamental aspects of this important topic in electrical engineering. The approach is eminently practical and requires little mathematics other than elementary differentiation, integration, and trigonometry. It will continue to appeal to students studying this conceptually challenging but fundamental subject. New sections on electromechanics (conversion of electric and magnetic energy in mechanical energy and vice versa) and high-frequency phenomena (transmission lines, waveguides, optical fibres, and radio propagation) enhance the usefulness of the book. Basic Electrical and Electronics Engineering provides an overview of the basics of electrical and electronic engineering that are required at the undergraduate level. The book allows students outside electrical and electronics engineering to easily

Electromagnetism for Engineers: An Introductory Course, Third Edition covers the principles of

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electromagnetism. The book discusses electric charges at rest; steady electric currents; and the magnetic field of steady electric currents. The text also describes electromagnetic induction; the magnetic effects of iron; and electromagnetic radiation. Mechanical and other kinds of engineers and engineering students who need knowledge on electromagnetism will find the book invaluable.

Presenting the proceedings from The Symposia on Electromagnetic and Electronic Engineering (SEEE 2014), this book provides a platform for international researchers, engineers and academics as well as industry professionals to present their research results and development activities in the area of Electromagnetic and Electronic Engineering. Topics covered include: Field and microwave technology, Electromagnetic environment effect, Electromagnetic materials, Electromagnetic protection, Electromagnetic pulse, Electromagnetic Modeling and Simulation, Microwave and antenna, Electromagnetic signal processing and Complex electromagnetic environment. Electronic Engineering gives focus to Linear and nonlinear Circuits, High voltage and insulation, Electrical Power Systems and automation, Motor and electric appliances, Electrical theory and technology Signals and systems and Electrical engineering and automation among others.

This book covers the basic electromagnetic principles and laws from the standpoint of engineering applications, focusing on time-varying fields. Numerous applications of the principles and law are given for engineering

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applications that are primarily drawn from digital system design and electromagnetic interference (Electromagnetic Compatibility or EMC). Clock speeds of digital systems are increasingly in the GHz range as are frequencies used in modern analog communication systems. This increasing frequency content demands that more electrical engineers understand these fundamental electromagnetic principles and laws in order to design high speed and high frequency systems that will successfully operate.

Engineers do not have the time to wade through rigorously theoretical books when trying to solve a problem. Beginners lack the expertise required to understand highly specialized treatments of individual topics. This is especially problematic for a field as broad as electromagnetics, which propagates into many diverse engineering fields. The time h

This edition aims to expand on the first edition and take the reader through to the wave equation on coaxial cable and free-space by using Maxwell's equations. The new chapters include time varying signals and fundamentals of Maxwell's equations. This book will introduce and discuss electromagnetic fields in an accessible manner. The author explains electroconductive fields and develops ideas relating to signal propagation and develops Maxwell's equations and applies them to propagation in a planar optical waveguide. The first of the new chapters introduces the idea of a travelling wave by considering the variation of voltage along a coaxial line. This concept will be used in the second new chapter which solves Maxwell's equations in free-space and

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then applies them to a planar optical waveguide in the third new chapter. As this is an area that most students find difficult, it links back to the earlier chapters to aid understanding. This book is intended for first- and second-year electrical and electronic undergraduates and can also be used for undergraduates in mechanical engineering, computing and physics. The book includes examples and homework problems. Introduces and examines electrostatic fields in an accessible manner Explains electroconductive fields Develops ideas relating to signal propagation Examines Maxwell's equations and relates them to propagation in a planar optical waveguide

Martin Sibley recently retired after 33 years of teaching at the University of Huddersfield. He has a PhD from Huddersfield Polytechnic in Preamplifier Design for Optical Receivers. He started his career in academia in 1986 having spent 3 years as a postgraduate student and then 2 years as a British Telecom-funded research fellow. His research work had a strong bias to the practical implementation of research, and he taught electromagnetism and communications at all levels since 1986. Dr. Sibley finished his academic career as a Reader in Communications, School of Computing and Engineering, University of Huddersfield. He has authored five books and published over 80 research papers.

Introduction and Survey of the Electromagnetic Spectrum; Fundamentals of Electric Fields; Fundamentals of Magnetic Fields; Electrodynamics; Radiation; Relativity and Quantum Physics; The Hidden Schematic; Transmission Lines; Waveguides and Shields; Circuits as Guides for Waves and S-

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Parameters; Antennas: How to Make Circuits That Radiate; EMC (Part I: Basics, Part II: PCB Techniques, Part III: Cabling); Lenses, Dishes, and Antenna Arrays; Diffraction; Frequency Dependence of Materials, Thermal Radiation, and Noise; Electrical Engineering Book Recommendations; Index.

This edition has been enhanced with new sections on electromechanics and high-frequency phenomena. Throughout the text, the mathematics is kept at the simplest level possible.

This book is addressed to engineers, applied mathematicians, and physicists involved in the design and analysis of electromagnetic systems. Its chief purpose is to clarify the structure of electromagnetism. It begins with the Faraday-Maxwell insight that in electromagnetism one is faced with an interconnected dynamical system in which space and time are closely linked with physical phenomena. An appropriate basis is given via differential geometry to describe local relationships, via and topology to describe the system. These tools are introduced in the context of Maxwell's equations in the familiar vector notation. Equations are greatly simplified by the geometrical approach, and the geometrical idea of symmetry unifies the various conservation laws. This book clarifies the relationship between fields, potentials, and sources. Links between macroscopic and quantum phenomena are explored from a geometric

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angle and there is a simple discussion of superconductivity.

Engineering Field Theory focuses on the applications of field theory in gravitation, electrostatics, magnetism, electric current flow, conductive heat transfer, fluid flow, and seepage.

The manuscript first ponders on electric flux, electrical materials, and flux function. Discussions focus on field intensity at the surface of a conductor, force on a charged surface, atomic properties, doublet and uniform field, flux tube and flux line, line charge and line sink, field of a surface charge, field intensity, flux density, permittivity, and Coulomb's law. The text then takes a look at gravitation and fluid flow, magnetic flux, and electric potential.

Topics include capacitance with mixed dielectric, capacitance, potential function, electric intensity, magnetization, field intensity, current loop and magnetic dipole, magnetic field of an electric current, velocity, pressure, gravitational field intensity, and gravitational constant. The book ponders on experimental techniques, numerical methods, and electromagnetic induction, including Hall effect, magnetic energy, method of construction, computer techniques, and space diagram. The publication is a highly recommended source material for engineers and researchers wanting to study further engineering field theory.

The second edition of *Electromagnetism: Theory and*

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Applications has been updated to cover some additional aspects of theory and nearly all modern applications. The semi-historical approach is unchanged, but further historical comments have been introduced at various places in the book to give a better insight into the development of the subject as well as to make the study more interesting and palatable to the students. What is New to This Edition Vector transformations in different coordinate systems have been included in the chapter on Vector Analysis. The treatment forms the basis of vector potentials for three-dimensional problems. Chapter 13 on Vector Potentials has been significantly expanded for a clear understanding of the properties of vector potentials, in order to also solve three-dimensional EM problems numerically. A section dealing with the derivation and interpretation of Hertz Vector has been included in Chapter 13. A practical problem on induction heating of flat metal plates has been added to the chapter on Magnetic Diffusion. The topics of wave guidance and radiation have been expanded with emphasis on practical aspects. Sections on analysis of cylindrical dielectric waveguide (e.g. of optical fibres) have been added to Chapters 18 and 22. New sections on basis and explanations of modal transmissions have been added. Characteristics and practical details of basic antenna structures and arrays have been treated in greater detail. Provides comprehensive treatment of

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FEM (Finite Element Method), covering both its variational basis and procedural details, to enable the readers to use this method without going into the heavy mathematics underlying the method.

Describes FDM (Finite Difference Method) in more detail with its convergence requirement. Introduces modern numerical methods like FDTD (Finite Difference Time Domain) and method of moments (MOM). A new chapter on Modern Topics and Applications covers both high frequency and low frequency applications. Appendices contain in-depth analysis of self-inductance and non-conservative fields (Appendix 6), proof regarding the boundary conditions (Appendix 8), theory of bicylindrical coordinate system to provide the physical basis of the circuit approach to the cylindrical transmission line systems (Appendix 10), and properties of useful functions like Bessel and Legendre functions (Appendix 9). The book is designed to serve as a core text for students of electrical engineering.

Besides, it will be useful to postgraduate physics students as well as research engineers and design and development engineers in industries.

Electromagnetic fields, both static and dynamic, form the foundational basis of all electrical and electronic engineering devices and systems. Aimed at undergraduate students, university teachers, design and consultant engineers and researchers this book presents an in-depth, simple and comprehensive

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reference source on electromagnetics engineering. In much of electrical and electronics engineering (including: analogue and digital telecommunications engineering; biomedical monitoring and diagnostic equipment; power systems engineering and sensor technology) getting back to the fundamental principles that govern the technologies, namely electromagnetic fields and waves, has become crucial for future customer friendly technology and systems. Electromagnetics Engineering Handbook has been written to enable undergraduate students studying electromagnetics engineering for the first time to gain an understanding of the essentials of the largely invisible, but powerful, electromagnetic fields governed by the four elegant Maxwell's equations. Moreover, the book helps to apply that knowledge through analytical and computational solutions of these frequency and material dependent electric and magnetic fields. As electrical and electronic engineering grows and subdivides into many specialities this book aims to inform the reader of the basic principles that govern all of these specialised systems and on how to apply that knowledge to understand and design devices and systems that may operate at vastly different frequencies and in various media (e.g. semiconductor materials, magnetic materials, biological tissues, outer space and sea water). It also deals with a range of different functions dependant on the area of application. For

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example at very low power frequencies electromagnetic fields perform vastly different functions from device to device, such as in power transformers; current transformers; infrared sensors; synchronous generators; superconducting devices; electric motors and electric powered transport systems. This handbook will be of great help to students, engineers, innovators and researchers working in a wide variety of disciplines

This introductory text provides coverage of both static and dynamic fields. There are references to computer visualisation (Mathcad) and computation throughout the text, and there are Mathcad electronic books available free on the Internet to help students visualise electromagnetic fields. Important equations are highlighted in the text, and there are examples and problems throughout, with answers to the problems at the back of the book.

This text, which introduces electromagnetism to students of electrical/electronic engineering & applied physics, emphasizes physical processes, the development of models for these processes & their use in the study of engineering problems.

Mathematical techniques are introduced gradually & methodically. The first section of the text covers basic electrostatics & magnetostatics & develops the framework within which a vast area of applications are treated in Part Two. This second section deals with situations where the couplings between electric

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& magnetic fields cannot be ignored. Part Three covers composite dielectrics/stress control, actuators, classification of machine types & description of circuit components. Throughout, a major effort has been made to help students relate mathematical formalism to physical ideas & practical systems. Several solid examples are given, followed by problems & answers.

This is the eBook of the printed book and may not include any media, website access codes, or print supplements that may come packaged with the bound book. Fundamentals of Electromagnetics for Electrical and Computer Engineering, First Edition is appropriate for all beginning courses in electromagnetics, in both electrical engineering and computer engineering programs. This is ideal for anyone interested in learning more about electromagnetics. Dr. N. Narayana Rao has designed this compact, one-semester textbook in electromagnetics to fully reflect the evolution of technologies in both electrical and computer engineering. This book's unique approach begins with Maxwell's equations for time-varying fields (first in integral and then in differential form), and also introduces waves at the outset. Building on these core concepts, Dr. Rao treats each category of fields as solutions to Maxwell's equations, highlighting the frequency behavior of physical structures. Next, he systematically introduces the topics of transmission

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lines, waveguides, and antennas. To keep the subject's geometry as simple as possible, while ensuring that students master the physical concepts and mathematical tools they will need, Rao makes extensive use of the Cartesian coordinate system. Topics covered in this book include: uniform plane wave propagation; material media and their interaction with uniform plane wave fields; essentials of transmission-line analysis (both frequency- and time-domain); metallic waveguides; and Hertzian dipole field solutions. Material on cylindrical and spherical coordinate systems is presented in appendices, where it can be studied whenever relevant or convenient. Worked examples are presented throughout to illuminate (and in some cases extend) key concepts; each chapter also contains a summary and review questions. (Note: this book provides a one-semester alternative to Dr. Rao's classic textbook for two-semester courses, *Elements of Engineering Electromagnetics*, now in its Sixth Edition.)

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

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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. The book Electromagnetic Field Theory caters to the students of BE/BTech Electronics and Communication Engineering, Electrical and Electronics Engineering, and Electronic Instrumentation Engineering, as electromagnetics is an integral part of their curricula. It covers a wide range of topics that deal with various physical and mathematical concepts, including vector functions, coordinate systems, integration and differentiation, complex numbers, and phasors. The book helps in understanding the electric and magnetic fields on different charge and current distributions, such as line, surface, and volume. It also explains the electromagnetic behaviour of waves, fields in transmission lines, and radiation in antennas. A

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number of electromagnetic applications are also included to develop the interest of students.

SALIENT FEATURES • Simple and easy-to-follow text • Complete coverage of the subject as per the syllabi of most universities • Lucid, well-explained concepts with clear examples • Relevant illustrations for better understanding and retention • Some of the illustrations provide three-dimensional view for in-depth knowledge • Numerous mathematical examples for full clarity of concepts • Chapter objectives at the beginning of each chapter for its overview • Chapter-end summary and exercises for quick review and to test your knowledge

Electromagnetics is one of the fundamental disciplines of electronic engineering. The author explains the development of field theory in relation to common electrical circuits and components, as opposed to just circuit theory, thus giving the reader a broader perspective of electrical circuits.

Essentially in two parts, this book will help students to gain an appreciation of the physical effects of electrical and magnetic fields. The first part covers the basic theory of electrostatics, electromagnetism and electroconductive fields and applies the theory to different transmission lines. It culminates in a comparison of the basic relationships that lie behind all the field systems covered. The second part covers the physical effects of dielectrics and ferrous materials on capacitors and coils. It is truly

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introductory with very little prior knowledge assumed. The mathematical techniques required to manipulate the theory are introduced from basics and there are numerous worked examples and problems. Self-assessment questions are given at the end of each chapter to allow the student to check their understanding of material before moving onto further chapters. This is an accessible and self-contained introduction to a topic that all physical scientists and engineers must get to grips with before developing their knowledge further.

Teaching Electromagnetics: Innovative Approaches and Pedagogical Strategies is a guide for educators addressing course content and pedagogical methods primarily at the undergraduate level in electromagnetic theory and its applications. Topics include teaching methods, lab experiences and hands-on learning, and course structures that help teachers respond effectively to trends in learning styles and evolving engineering curricula. The book grapples with issues related to the recent worldwide shift to remote teaching. Each chapter begins with a high-level consideration of the topic, reviews previous work and publications, and gives the reader a broad picture of the topic before delving into details. Chapters include specific guidance for those who want to implement the methods and assessment results and evaluation of the effectiveness of the methods. Respecting the limited

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time available to the average teacher to try new methods, the chapters focus on why an instructor should adopt the methods proposed in it. Topics include virtual laboratories, computer-assisted learning, and MATLAB® tools. The authors also review flipped classrooms and online teaching methods that support remote teaching and learning. The end result should be an impact on the reader represented by improvements to his or her practical teaching methods and curricular approach to electromagnetics education. The book is intended for electrical engineering professors, students, lab instructors, and practicing engineers with an interest in teaching and learning. In summary, this book:

- Surveys methods and tools for teaching the foundations of wireless communications and electromagnetic theory
- Presents practical experience and best practices for topical coverage, course sequencing, and content
- Covers virtual laboratories, computer-assisted learning, and MATLAB tools
- Reviews flipped classroom and online teaching methods that support remote teaching and learning
- Helps instructors in RF systems, field theory, and wireless communications bring their teaching practice up to date

Dr. Krishnasamy T. Selvan is Professor in the Department of Electronics & Communication Engineering, SSN College of Engineering, since June 2012. Dr. Karl F. Warnick is Professor in the Department of Electrical and

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