

CHAPTER

4

LINEAR WIRE ANTENNAS

4.1 INTRODUCTION

Wire antennas, linear or curved, are some of the oldest, simplest, cheapest, and in many cases the most versatile for many applications. It should not then come as a surprise to the reader that we begin our analysis of antennas by considering some of the oldest, simplest, and most basic configurations. Initially we will try to minimize the complexity of the antenna structure and geometry to keep the mathematical details to a minimum.

4.2 INFINITESIMAL DIPOLE

An infinitesimal linear wire ($l \ll \lambda$) is positioned symmetrically at the origin of the coordinate system and oriented along the z axis, as shown in Figure 4.1(a). Although infinitesimal dipoles are not very practical, they are used to represent capacitor-plate (also referred to as *top-hat-loaded*) antennas. In addition, they are utilized as building blocks of more complex geometries. The wire, in addition to being very small ($l \ll \lambda$), is very thin ($a \ll \lambda$). The current is assumed to be constant and given by

$$\mathbf{I}(z') = \hat{\mathbf{a}}_z I_0 \quad (4-1)$$

where $I_0 = \text{constant}$.

4.2.1 Radiated Fields

To find the fields radiated by the current element, the two-step procedure of Figure 3.1 is used. It will be required to determine first \mathbf{A} and \mathbf{F} and then find the \mathbf{E} and \mathbf{H} . The functional relation between \mathbf{A} and the source \mathbf{J} is given by (3-49), (3-51), or (3-53). Similar relations are available for \mathbf{F} and \mathbf{M} , as given by (3-50), (3-52), and (3-54).

Since the source only carries an electric current \mathbf{I}_e , \mathbf{I}_m and the potential function \mathbf{F} are zero. To find \mathbf{A} we write

$$\mathbf{A}(x, y, z) = \frac{\mu}{4\pi} \int_V \mathbf{I}_e(x', y', z') \frac{e^{-j\beta R}}{R} dV' \quad (4-2)$$

Antenna Theory By Balanis Chapter 14

**Sabyasachi SenGupta,Ahmed F.
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Kumar Bhoi**

Antenna Theory By Balanis Chapter 14:

Antenna Theory Constantine A. Balanis, 2016-02-01 Updated with color and gray scale illustrations a companion website housing supplementary material and new sections covering recent developments in antenna analysis and design This book introduces the fundamental principles of antenna theory and explains how to apply them to the analysis design and measurements of antennas Due to the variety of methods of analysis and design and the different antenna structures available the applications covered in this book are made to some of the most basic and practical antenna configurations Among these antenna configurations are linear dipoles loops arrays broadband antennas aperture antennas horns microstrip antennas and reflector antennas The text contains sufficient mathematical detail to enable undergraduate and beginning graduate students in electrical engineering and physics to follow the flow of analysis and design Readers should have a basic knowledge of undergraduate electromagnetic theory including Maxwell's equations and the wave equation introductory physics and differential and integral calculus Presents new sections on flexible and conformal bowtie Vivaldi antenna antenna miniaturization antennas for mobile communications dielectric resonator antennas and scale modeling Provides color and gray scale figures and illustrations to better depict antenna radiation characteristics Includes access to a companion website housing MATLAB programs Java based applets and animations Power Point notes Java based interactive questionnaires and a solutions manual for instructors Introduces over 100 additional end of chapter problems *Antenna Theory Analysis and Design* Fourth Edition is designed to meet the needs of senior undergraduate and beginning graduate level students in electrical engineering and physics as well as practicing engineers and antenna designers Constantine A Balanis received his BSEE degree from the Virginia Tech in 1964 his MEE degree from the University of Virginia in 1966 his PhD in Electrical Engineering from The Ohio State University in 1969 and an Honorary Doctorate from the Aristotle University of Thessaloniki in 2004 From 1964 to 1970 he was with the NASA Langley Research Center in Hampton VA and from 1970 to 1983 he was with the Department of Electrical Engineering of West Virginia University In 1983 he joined Arizona State University and is now Regents Professor of Electrical Engineering Dr Balanis is also a life fellow of the IEEE

Balanis' Advanced Engineering Electromagnetics Constantine A. Balanis, 2024-01-31 *Balanis Advanced Engineering Electromagnetics* The latest edition of the foundational guide to advanced electromagnetics Balanis third edition of *Advanced Engineering Electromagnetics* a global best seller for over 30 years covers the advanced knowledge engineers involved in electromagnetics need to know particularly as the topic relates to the fast moving continuously evolving and rapidly expanding field of wireless communications The immense interest in wireless communications and the expected increase in wireless communications systems projects antennas microwaves and wireless communications points to an increase in the number of engineers needed to specialize in this field Highlights of the 3rd Edition include A new chapter on Artificial Impedance Surfaces AIS contains material on current and advanced EM technologies including the exciting and fascinating

topic of metasurfaces for Control and broadband RCS reduction using checkerboard designs Optimization of antenna fundamental parameters such as input impedance directivity realized gain amplitude radiation pattern Leaky wave antennas using 1 D and 2 D polarization diverse holographic high impedance metasurfaces for antenna radiation control and optimization Associated MATLAB programs for the design of checkerboard metasurfaces for RCS reduction and metasurface printed antennas and holographic L WA for radiation control and optimization Throughout the book there are Additional examples numerous end of chapter problems and PPT notes Fifty three MATLAB computer programs for computations graphical visualizations and animations Nearly 4 500 multicolor PowerPoint slides are available for self study or lecture use

Fixed Broadband Wireless System Design Harry R. Anderson, 2003-03-14 Fixed broadband networks can provide far higher data rates and capacity than the currently envisioned 3G and 4G mobile cellular systems Achieving higher data rates is due to the unique technical properties of fixed systems in particular the use of high gain and adaptive antennas wide frequency bands dynamic data rate and channel resource allocation and advanced multiple access techniques Fixed Broadband Wireless System Design is a comprehensive presentation of the engineering principles advanced engineering techniques and practical design methods for planning and deploying fixed wireless systems including Point to point LOS and NLOS network design Point to point microwave link design including active and passive repeaters Consecutive point and mesh network planning Advanced empirical and physical propagation modeling including ray tracing Detailed microwave fading models for multipath and rain NLOS indoor and outdoor propagation and fading models Propagation environment models including terrain morphology buildings and atmospheric effects Novel mixed application packet traffic modeling for dimensioning network capacity Narrow beam wide beam and adaptive smart antennas MIMO systems and space time coding Channel planning including fixed and dynamic channel assignment and dynamic packet assignment IEEE 802 11b and 802 11a WLAN system design Free space optic FSO link design At present there are no titles available that provide such a concise presentation of the wide variety of systems frequency bands multiple access techniques and other factors that distinguish fixed wireless systems from mobile wireless systems Fixed Broadband Wireless System Design is essential reading for design system and RF engineers involved in the design and deployment of fixed broadband wireless systems fixed wireless equipment vendors and academics and postgraduate students in the field Microwave Engineering David M. Pozar, 2011-11-22 The 4th edition of this classic text provides a thorough coverage of RF and microwave engineering concepts starting from fundamental principles of electrical engineering with applications to microwave circuits and devices of practical importance Coverage includes microwave network analysis impedance matching directional couplers and hybrids microwave filters ferrite devices noise nonlinear effects and the design of microwave oscillators amplifiers and mixers Material on microwave and RF systems includes wireless communications radar radiometry and radiation hazards A large number of examples and end of chapter problems test the reader's understanding of the material The 4th edition includes

new and updated material on systems noise active devices and circuits power waves transients RF CMOS circuits and more

Proceedings of the 2009 International Conference on Signals, Systems and Automation (ICSSA 2009) Himanshu Soni, 2010-04-30 This book is a collection of papers from the 2009 International Conference on Signals Systems and Automation ICSSA 2009 The conference at a glance Pre conference Workshops Tutorials on 27th Dec 2009 Five Plenary talks Paper Poster Presentation 28 29 Dec 2009 Demonstrations by SKYVIEW Inc SLS Inc BSNL Baroda Electric Meters SIS On line paper submission facility on website 200 papers are received from India and abroad Delegates from different countries including Poland Iran USA Delegates from 16 states of India Conference website is seen by more than 3000 persons across the world 27 countries and 120 cities *Advanced Engineering Electromagnetics* Constantine A. Balanis, 2012-01-24 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 **Electronics and Communications Engineering** T. Kishore Kumar, Ravi Kumar Jatoth, V .V. Mani, 2019-06-07 Every day millions of people are unaware of the amazing processes that take place when using their phones connecting to broadband internet watching television or even the most basic action of flipping on a light switch Advances are being continually made in not only the transmission of this data but also in the new methods of receiving it These advancements come from many different sources and from engineers who have engaged in research design development and implementation of electronic equipment used in communications systems This volume addresses a selection of important current advancements in the electronics and communications engineering fields focusing on signal processing chip design and networking technology The sections in the book cover Microwave and antennas Communications systems Very large scale integration Embedded systems Intelligent control and signal processing systems *Systems Engineering of Phased Arrays* Rick Sturdivant, Clifton Quan, Enson Chang, 2018-11-30 Phased arrays while traditionally used in radar systems are now being used or proposed for use in internet of things IoT networks high speed back haul communication terabit per second satellite systems 5G mobile networks and mobile phones This book considers systems engineering of phased arrays and addresses not only radar but also these modern applications It presents a system level perspective and approach that is essential for the successful development of modern

phased arrays Using practical examples this book helps solve problems often encountered by technical professionals Thermal management challenges antenna element design issues and architectures solutions are explored as well as the benefits and challenges of digital beam forming This book provides the information required to train engineers to design and develop phased arrays and contains questions at the end of each chapter that professors will find useful for instruction Printed Antennas Praveen Kumar Malik,Arshi Naim,Ramendra Singh,2022-12-15 This collection covers different printed microstrip antenna designs from rectangular to circular broadband dual band and millimeter wave microstrip antennas to microstrip arrays It further presents a new analysis of the rectangular and circular microstrip antenna efficiency and surface wave phenomena The book Covers the latest advances and applications of microstrip antennas Discusses methods and techniques used for the enhancement of the performance parameters of the microstrip antenna Presents low power wide area network LPWAN proximity coupled antenna for Internet of Things applications Highlights a new analysis of rectangular and circular microstrip antenna efficiency and surface wave phenomena Showcases implantable antennas H shaped antennas and wideband implantable antennas for biomedical applications Printed Antennas discusses the latest advances such as the Internet of Things for antenna applications device to device communication satellite communication and wearable textile antenna in the field of communication It further presents methods and techniques used for the enhancement of the performance parameters of the microstrip antenna and covers the design of conformal and miniaturized antenna structures for various applications It will serve as an ideal reference text for senior undergraduates graduate students and researchers in fields including electrical engineering electronics and communications engineering and computer engineering

Electromagnetic Optimization by Genetic Algorithms Yahya Rahmat-Samii,Eric Michielssen,1999-07-23 Authoritative coverage of a revolutionary technique for overcoming problems in electromagnetic design Genetic algorithms are stochastic search procedures modeled on the Darwinian concepts of natural selection and evolution The machinery of genetic algorithms utilizes an optimization methodology that allows a global search of the cost surface via statistical random processes dictated by the Darwinian evolutionary concept These easily programmed and readily implemented procedures robustly locate extrema of highly multimodal functions and therefore are particularly well suited to finding solutions to a broad range of electromagnetic optimization problems Electromagnetic Optimization by Genetic Algorithms is the first book devoted exclusively to the application of genetic algorithms to electromagnetic device design Compiled by two highly competent and well respected members of the electromagnetics community this book describes numerous applications of genetic algorithms to the design and optimization of various low and high frequency electromagnetic components Special features include Introduction by David E Goldberg A Meditation on the Application of Genetic Algorithms Design of linear and planar arrays using genetic algorithms Application of genetic algorithms to the design of broadband wire and integrated antennas Genetic algorithm driven design of dielectric gratings and frequency selective surfaces Synthesis of magnetostatic

devices using genetic algorithms Application of genetic algorithms to multiobjective electromagnetic backscattering optimization A comprehensive list of the up to date references applicable to electromagnetic design problems Supplemented with more than 250 illustrations Electromagnetic Optimization by Genetic Algorithms is a powerful resource for electrical engineers interested in modern electromagnetic designs and an indispensable reference for university researchers

Antenna Theory and Design Warren L. Stutzman, Gary A. Thiele, 2012-05-22 Stutzman's 3rd edition of Antenna Theory and Design provides a more pedagogical approach with a greater emphasis on computational methods New features include additional modern material to make the text more exciting and relevant to practicing engineers new chapters on systems low profile elements and base station antennas organizational changes to improve understanding more details to selected important topics such as microstrip antennas and arrays and expanded measurements topic Microelectronics, Electromagnetics and Telecommunications Suresh Chandra Satapathy, N Bheema Rao, S Srinivas Kumar, C Dharma Raj, V Malleswara Rao, G V K Sarma, 2015-12-24 This volume contains 73 papers presented at ICMEET 2015 International Conference on Microelectronics Electromagnetics and Telecommunications The conference was held during 18-19 December 2015 at Department of Electronics and Communication Engineering GITAM Institute of Technology GITAM University Visakhapatnam INDIA This volume contains papers mainly focused on Antennas Electromagnetics Telecommunication Engineering and Low Power VLSI Design *Radar Systems Principles* Harold R. Raemer, 1996-10-30 In planning a radar system having the proper mathematical modeling of propagation effects clutter and target statistics is essential Radar Systems Principles provides a strong theoretical basis for the myriad of formulas and rules of thumb required for analysis conceptual design and performance evaluation of radar systems Mathematical derivations of formulas commonly used by radar engineers are presented with detailed discussions of the assumptions behind these expressions and their ranges of validity These principles are used in a wide range of radar applications Radar Systems Principles makes it easy to understand the steps in calculating various formulas and when and how these formulas are used A set of problems is provided for each chapter enabling you to check your progress in applying the principles discussed in each section of the text There are more than 170 figures illustrating key concepts Numerous references to well known books on radar for coverage of practical design issues and other specialized topics are given Radar Systems Principles is an ideal textbook for advanced undergraduates and first year graduate students and also makes an excellent vehicle for self study by engineers wishing to enhance their understanding of radar principles and their implication in actual systems **Handbook of Reflector**

Antennas and Feed Systems Volume II: Feed Systems Lotfollah Shafai, Satish K. Sharma, Sudhakar Rao, 2013-07-01 This is the first truly comprehensive and most up to date handbook available on modern reflector antennas and feed sources for diversified space and ground applications There has never been such an all encompassing reflector handbook in print and no currently available title offers coverage of such recent research developments The Handbook consists of three volumes

Volume II focuses on feed sources Reflector antennas are extraordinary devices that combine high gain with geometrical simplicity and can operate in broad frequency bands Their performance however depends on the electrical characteristics of the feed system with which they operate This comprehensive volume provides you with a solid understanding of feed system theory design and analysis Featuring chapters authored by experts in each aspect of feed systems this book takes you from fundamental mathematical techniques electrically small and large dual reflectors feed geometry and telemetry tracking and command antennas and more Throughout the book numerous examples are provided to guide you in the practical aspects of feed design

Microwave Passive and Antenna Components Kai Chang, 1989 Part of a four volume compendium of principles and design data for practising microwave and optical engineers this volume covers microwave components and optical components with most of the design results presented in graphic and tabular form

Proceedings of 2nd International Conference on Micro-Electronics, Electromagnetics and Telecommunications Suresh Chandra Satapathy, Vikrant Bhateja, P. Satish Rama Chowdary, V.V.S.S. Sameer Chakravarthy, Jaume Anguera, 2017-09-06 The book is a collection of best papers presented in the Second International Conference on Microelectronics Electromagnetics and Telecommunication ICMEET 2016 an international colloquium which aims to bring together academic scientists researchers and research scholars to discuss the recent developments and future trends in the fields of microelectronics electromagnetics and telecommunication Microelectronics research investigates semiconductor materials and device physics for developing electronic devices and integrated circuits with data energy efficient performance in terms of speed power consumption and functionality The book discusses various topics like analog digital and mixed signal circuits bio medical circuits and systems RF circuit design microwave and millimeter wave circuits green circuits and systems analog and digital signal processing nano electronics and giga scale systems VLSI circuits and systems SoC and NoC MEMS and NEMS VLSI digital signal processing wireless communications cognitive radio and data communication

Satellite Communications Network Design and Analysis Kenneth Y. Jo, 2011 This authoritative book provides a thorough understanding of the fundamental concepts of satellite communications SATCOM network design and performance assessments You find discussions on a wide class of SATCOM networks using satellites as core components as well as coverage key applications in the field This in depth resource presents a broad range of critical topics from geosynchronous Earth orbiting GEO satellites and direct broadcast satellite systems to low Earth orbiting LEO satellites radio standards and protocols This invaluable reference explains the many specific uses of satellite networks including small terminal wireless and mobile communications systems Moreover this book presents advanced topics such as satellite RF link analyses optimum transponder loading on board processing antenna characteristics protected systems information assurance and spread spectrums You are introduced to current and future SATCOM systems and find details on their performance supportabilities This cutting edge book also presents trends in multimedia satellite applications and IP services over satellites

Phased Array Antenna Handbook, Third Edition Robert J.

Mailloux,2017-11-30 This completely revised third edition of an Artech House classic Phased Array Antenna Handbook Second Edition offers an up to date and comprehensive treatment of array antennas and systems This edition provides a wealth of new material including expanded coverage of phased array and multiple beam antennas New modern machine learning techniques used for analysis are included Additional material on wideband antennas and wideband coverage in array antennas are incorporated in this book including new methods devices and technologies that have developed since the second edition A detailed treatment of antenna system noise sections on antenna pattern synthesis developments in subarray technology and in depth coverage of array architecture and components are additional new features of this book The book explores design elements that demonstrate how to size an array system with speed and confidence Moreover this resource provides expanded coverage of systems aspects of arrays for radar and communications Supported with numerous equations and illustrations this practical book helps evaluate basic antenna parameters such as gain sidelobe levels and noise Readers learn how to compute antenna system noise design subarray geometries for given bandwidth scan and sidelobe constraints and choose array illumination tapers for given sidelobe levels CDMA Techniques for Third Generation Mobile Systems Francis Swarts,Pieter van Rooyen,Ian Oppermann,Michiel P. Lötter,2012-12-06 CDMA Techniques for Third Generation Mobile Systems presents advanced techniques for analyzing and developing third generation mobile telecommunication systems Coverage includes analysis of CDMA based systems multi user receivers Turbo coding for mobile radio applications spatial and temporal processing techniques as well as software radio techniques Special emphasis has been given to recent advances in coding techniques smart antenna systems spatial filtering and software implementation issues Internationally recognized specialists contributed to this volume and each chapter has been reviewed and edited for uniformity CDMA Techniques for Third Generation Mobile Systems is an invaluable reference work for engineers and researchers involved in the development of specific CDMA systems **Advances in Smart Grid and Renewable Energy** Sabyasachi SenGupta,Ahmed F. Zobaa,Karma Sonam Sherpa,Akash Kumar Bhoi,2017-10-25 This volume comprises select proceedings of ETAEERE 2016 The volume offers state of the art chapters on energy management systems EMS renewable energy resources micro generation green communications architectures and frameworks green computing and education as well as energy aware process optimization The contents covers a wide variety of topics and aspects including management of renewable energy systems and environmental challenges The contents of this volume will be useful to researchers and practicing engineers working in the areas of smart grids and renewable energy generation distribution and management

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