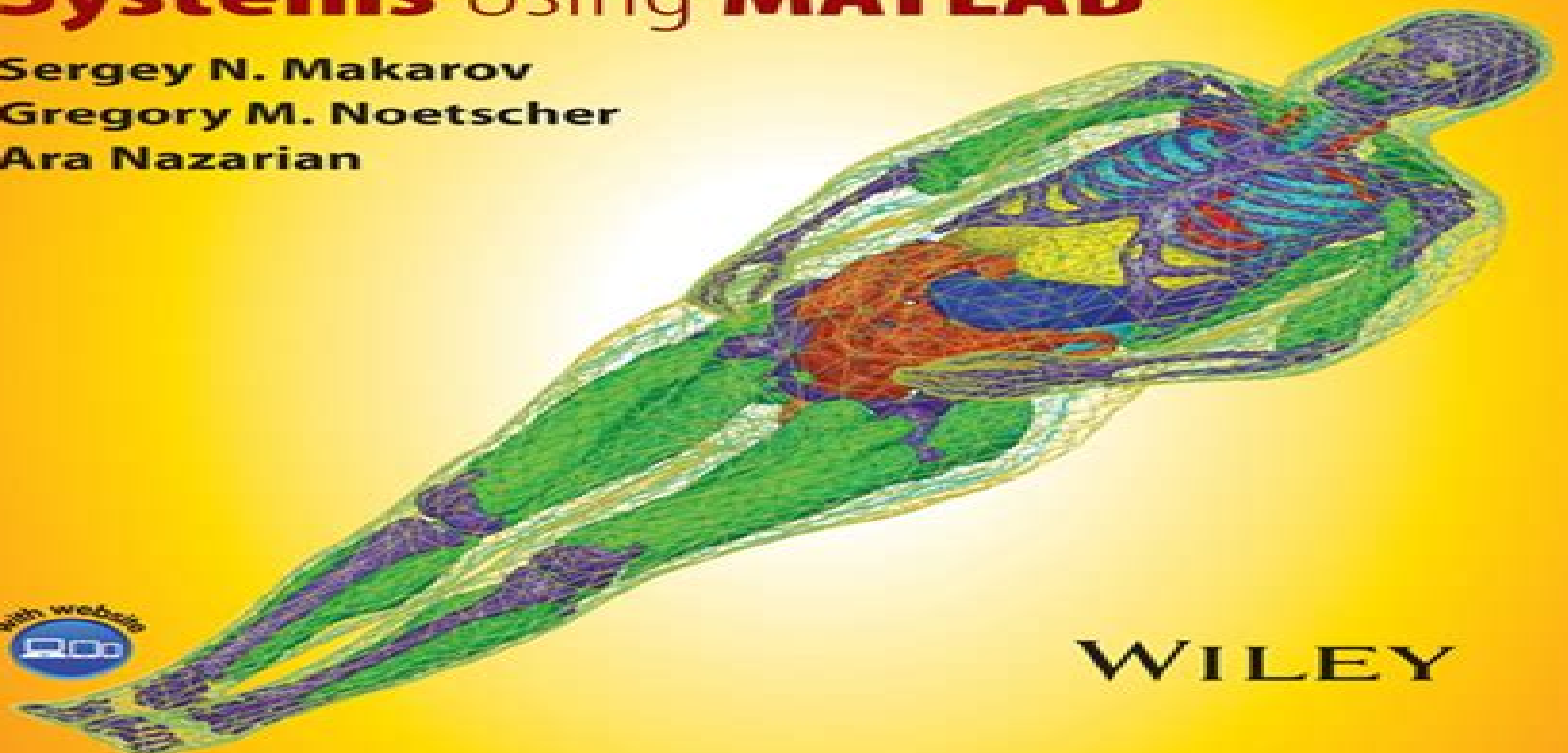


# Low-Frequency Electromagnetic Modeling for **Electrical** and **Biological** **Systems** Using **MATLAB®**

Sergey N. Makarov  
Gregory M. Noetscher  
Ara Nazarian



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# Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab

**Sergey Makarov, Marc Horner, Gregory  
Noetscher**



## **Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab:**

**Low-Frequency Electromagnetic Modeling for Electrical and Biological Systems Using MATLAB** Sergey N. Makarov, Gregory M. Noetscher, Ara Nazarian, 2015-05-12 Provides a detailed and systematic description of the Method of Moments Boundary Element Method for electromagnetic modeling at low frequencies and includes hands on application based MATLAB modules with user friendly and intuitive GUI and a highly visualized interactive output Includes a full body computational human phantom with over 120 triangular surface meshes extracted from the Visible Human Project Female dataset of the National library of Medicine and fully compatible with MATLAB and major commercial FEM BEM electromagnetic software simulators This book covers the basic concepts of computational low frequency electromagnetics in an application based format and hones the knowledge of these concepts with hands on MATLAB modules The book is divided into five parts Part 1 discusses low frequency electromagnetics basic theory of triangular surface mesh generation and computational human phantoms Part 2 covers electrostatics of conductors and dielectrics and direct current flow Linear magnetostatics is analyzed in Part 3 Part 4 examines theory and applications of eddy currents Finally Part 5 evaluates nonlinear electrostatics Application examples included in this book cover all major subjects of low frequency electromagnetic theory In addition this book includes complete or summarized analytical solutions to a large number of quasi static electromagnetic problems Each Chapter concludes with a summary of the corresponding MATLAB modules Combines fundamental electromagnetic theory and application oriented computation algorithms in the form of stand alone MATLAB modules Makes use of the three dimensional Method of Moments MoM for static and quasistatic electromagnetic problems Contains a detailed full body computational human phantom from the Visible Human Project Female embedded implant models and a collection of homogeneous human shells Low Frequency Electromagnetic Modeling for Electrical and Biological Systems Using MATLAB is a resource for electrical and biomedical engineering students and practicing researchers engineers and medical doctors working on low frequency modeling and bioelectromagnetic applications

**Low-Frequency Electromagnetic Modeling for Electrical and Biological Systems Using MATLAB** Sergey N. Makarov, Gregory M. Noetscher, Ara Nazarian, 2015-05-13 Provides a detailed and systematic description of the Method of Moments Boundary Element Method for electromagnetic modeling at low frequencies and includes hands on application based MATLAB modules with user friendly and intuitive GUI and a highly visualized interactive output Includes a full body computational human phantom with over 120 triangular surface meshes extracted from the Visible Human Project Female dataset of the National library of Medicine and fully compatible with MATLAB and major commercial FEM BEM electromagnetic software simulators This book covers the basic concepts of computational low frequency electromagnetics in an application based format and hones the knowledge of these concepts with hands on MATLAB modules The book is divided into five parts Part 1 discusses low frequency electromagnetics basic theory of triangular surface mesh generation and computational human phantoms Part

2 covers electrostatics of conductors and dielectrics and direct current flow Linear magnetostatics is analyzed in Part 3 Part 4 examines theory and applications of eddy currents Finally Part 5 evaluates nonlinear electrostatics Application examples included in this book cover all major subjects of low frequency electromagnetic theory In addition this book includes complete or summarized analytical solutions to a large number of quasi static electromagnetic problems Each Chapter concludes with a summary of the corresponding MATLAB modules Combines fundamental electromagnetic theory and application oriented computation algorithms in the form of stand alone MATLAB modules Makes use of the three dimensional Method of Moments MoM for static and quasistatic electromagnetic problems Contains a detailed full body computational human phantom from the Visible Human Project Female embedded implant models and a collection of homogeneous human shells Low Frequency Electromagnetic Modeling for Electrical and Biological Systems Using MATLAB is a resource for electrical and biomedical engineering students and practicing researchers engineers and medical doctors working on low frequency modeling and bioelectromagnetic applications

**Computational Electromagnetics with MATLAB, Fourth Edition** Matthew N.O. Sadiku, 2018-07-20 This fourth edition of the text reflects the continuing increase in awareness and use of computational electromagnetics and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods It teaches the readers how to pose numerically analyze and solve EM problems to give them the ability to expand their problem solving skills using a variety of methods and to prepare them for research in electromagnetism Includes new homework problems in each chapter Each chapter is updated with the current trends in CEM Adds a new appendix on CEM codes which covers commercial and free codes Provides updated MATLAB code

**Brain and Human Body Modeling 2020** Sergey N. Makarov, 2021 The 41st Annual International Conference of the IEEE EMBS took place between July 23 and 27 2019 in Berlin Germany The focus was on Biomedical engineering ranging from wellness to intensive care This conference provided an opportunity for researchers from academia and industry to discuss a variety of topics relevant to EMBS and hosted the 4th Annual Invited Session on Computational Human Models At this session a bevy of research related to the development of human phantoms was presented together with a substantial variety of practical applications explored through simulation

*Brain and Human Body Modeling* Sergey Makarov, Marc Horner, Gregory Noetscher, 2019-08-27 This open access book describes modern applications of computational human modeling with specific emphasis in the areas of neurology and neuroelectromagnetics depression and cancer treatments radio frequency studies and wireless communications Special consideration is also given to the use of human modeling to the computational assessment of relevant regulatory and safety requirements Readers working on applications that may expose human subjects to electromagnetic radiation will benefit from this book s coverage of the latest developments in computational modelling and human phantom development to assess

a given technology's safety and efficacy in a timely manner Describes construction and application of computational human models including anatomically detailed and subject specific models Explains new practices in computational human modeling for neuroelectromagnetics electromagnetic safety and exposure evaluations Includes a survey of modern applications for which computational human models are critical Describes cellular level interactions between the human body and electromagnetic fields

*Antenna and EM Modeling with MATLAB Antenna Toolbox* Sergey N. Makarov, Vishwanath Iyer, Shashank Kulkarni, Steven R. Best, 2021-04-30 ANTENNA AND EM MODELING WITH MATLAB ANTENNA TOOLBOX™ An essential text to MATLAB Antenna Toolbox™ as accessible and easy to use full wave antenna modeling tool Antenna and EM Modeling with MATLAB Antenna Toolbox™ is a textbook on antennas intended for a one semester course The core philosophy is to introduce the key antenna concepts and follow them up with full wave modeling and optimization in the MATLAB Antenna Toolbox™ Such an approach will enable immediate testing of theoretical concepts by experimenting in software It also provides the direct path to research work The fundamental families of antennas dipoles loops patches and traveling wave antennas are discussed in detail together with the respective antenna arrays Using antenna parameters such as impedance reflection coefficient efficiency directivity and gain the reader is introduced to the different ways of understanding the performance of an antenna Written for senior undergraduates graduates as well as RF Antenna engineers Antenna and EM Modeling with Antenna Toolbox™ is a resource that Provides 14 video assisted laboratories on using Antenna Toolbox™ Includes approximately 50 real world examples in antenna and array design Offers approximately 200 homework problems Provides multiple ready to use standalone MATLAB scripts

**Deterministic and Stochastic Modeling in Computational Electromagnetics** Dragan Poljak, Anna Susnjara, 2023-12-07 Deterministic and Stochastic Modeling in Computational Electromagnetics Help protect your network with this important reference work on cyber security Deterministic computational models are those for which all inputs are precisely known whereas stochastic modeling reflects uncertainty or randomness in one or more of the data inputs Many problems in computational engineering therefore require both deterministic and stochastic modeling to be used in parallel allowing for different degrees of confidence and incorporating datasets of different kinds In particular non intrusive stochastic methods can be easily combined with widely used deterministic approaches enabling this more robust form of data analysis to be applied to a range of computational challenges Deterministic and Stochastic Modeling in Computational Electromagnetics provides a rare treatment of parallel deterministic stochastic computational modeling and its beneficial applications Unlike other works of its kind which generally treat deterministic and stochastic modeling in isolation from one another it aims to demonstrate the usefulness of a combined approach and present particular use cases in which such an approach is clearly required It offers a non intrusive stochastic approach which can be incorporated with minimal effort into virtually all existing computational models Readers will also find A range of specific examples demonstrating the efficiency of deterministic stochastic modeling Computational examples

of successful applications including ground penetrating radars GPR radiation from 5G systems transcranial magnetic and electric stimulation TMS and TES and more Introduction to fundamental principles in field theory to ground the discussion of computational modeling Deterministic and Stochastic Modeling in Computational Electromagnetics is a valuable reference for researchers including graduate and undergraduate students in computational electromagnetics as well as to

multidisciplinary researchers engineers physicists and mathematicians **Electromagnetic Imaging for a Novel Generation of Medical Devices** Francesca Vipiana, Lorenzo Crocco, 2023-06-29 This book offers the first comprehensive coverage of microwave medical imaging with a special focus on the development of novel devices and methods for different applications in both the diagnosis and treatment of various diseases Upon introducing the fundamentals of electromagnetic imaging it guides the readers to their use in practice by providing extensive information on the corresponding measurement and testing techniques In turn it discusses current challenges in data processing and analysis presenting effective novel solutions developed by different research groups It also describes state of the art medical devices which were designed for specific applications such as brain stroke monitoring lymph node diagnosis image guided hyperthermia and chemotherapy response monitoring The chapters which report on the results of the EU funded project EMERALD ElectroMagnetic imaging for a novel genERation of medicAL Devices are written by leading European engineering groups in electromagnetic medical imaging whose coordinated action is expected to accelerate the translation of this technology from research bench to patient bedside All in all this book offers an authoritative guide to microwave imaging with a special focus on medical imaging for electrical and biomedical engineers and applied physicists and mathematicians It is also intended to inform medical doctors and imaging technicians on the state of the art in non invasive imaging technologies at the purpose of inspiring and fostering the translation of research into clinical prototypes by promoting a stronger collaboration between academic institutions industrial partners hospitals and university medical centers **Electromagnetics of Body Area Networks** Douglas H.

Werner, Zhi Hao Jiang, 2016-07-20 The book is a comprehensive treatment of the field covering fundamental theoretical principles and new technological advancements state of the art device design and reviewing examples encompassing a wide range of related sub areas In particular the first area focuses on the recent development of novel wearable and implantable antenna concepts and designs including metamaterial based wearable antennas microwave circuit integrated wearable filtering antennas and textile and or fabric material enabled wearable antennas The second set of topics covers advanced wireless propagation and the associated statistical models for on body in body and off body modes Other sub areas such as efficient numerical human body modeling techniques artificial phantom synthesis and fabrication as well as low power RF integrated circuits and related sensor technology are also discussed These topics have been carefully selected for their transformational impact on the next generation of body area network systems and beyond **The New Frontier of Network Physiology: From Temporal Dynamics to the Synchronization and Principles of Integration in Networks**



This book delves into Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab. Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab is a vital topic that needs to be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:
  - Chapter 1: Introduction to Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab
  - Chapter 2: Essential Elements of Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab
  - Chapter 3: Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab in Everyday Life
  - Chapter 4: Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab in Specific Contexts
  - Chapter 5: Conclusion
2. In chapter 1, the author will provide an overview of Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab. The first chapter will explore what Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab is, why Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab is vital, and how to effectively learn about Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab.
3. In chapter 2, the author will delve into the foundational concepts of Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab. The second chapter will elucidate the essential principles that must be understood to grasp Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab in its entirety.
4. In chapter 3, this book will examine the practical applications of Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab in daily life. The third chapter will showcase real-world examples of how Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab can be effectively utilized in everyday scenarios.
5. In chapter 4, the author will scrutinize the relevance of Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab in specific contexts. This chapter will explore how Low Frequency Electromagnetic



Modeling For Electrical And Biological Systems Using Matlab is applied in specialized fields, such as education, business, and technology.

6. In chapter 5, the author will draw a conclusion about Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab. The final chapter will summarize the key points that have been discussed throughout the book. The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Low Frequency Electromagnetic Modeling For Electrical And Biological Systems Using Matlab.

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