Computational Methods For Physicists Compendium For Students Graduate Texts In Physics

Computational Methods in Reactor Shielding deals with the mathematical processes involved in how to effectively control the dangerous effect of nuclear radiation. Reactor shielding is considered an important aspect in the operation of reactor systems to ensure the safety of personnel and others that can be directly or indirectly affected. Composed of seven chapters, the book discusses ionizing radiation and how it aids in the control and containment of radioactive substances that are considered harmful to all living things. The text also outlines the necessary radiation quantities and units that are needed for a systemic control of shielding and presents an examination of the main sources of nuclear radiation. A discussion of the gamma photon cross sections and an introduction to BMIX, a computer program used in illustrating a technique in identifying the gamma ray build-up factor for a reactor shield, are added. The selection also discusses various mathematical representations and areas of shielding theory that are being used in radiation shielding. The book is of great value to those involved in the development and implementation of systems to minimize and control the dangerous and lethal effect of radiation.

This comprehensively revised second edition of Computational Systems Biology discusses the experimental and theoretical foundations of the function of biological systems at the molecular, cellular or organismal level over temporal and spatial scales, as systems biology advances to provide clinical solutions to complex medical problems. In particular the work focuses on the engineering of biological systems and network modeling. Logical information flow aids understanding of basic building blocks of life through disease phenotypes Evolved principles gives insight into underlying organizational principles of biological organizations, and systems processes, governing functions such as adaptation or response patterns Coverage of technical tools and systems helps researchers to understand and resolve specific systems biology problems using advanced computation Multi-scale modeling on disparate scales aids researchers understanding of dependencies and constraints of spatio-temporal relationships fundamental to biological organization and function.

The notion of renormalization is at the core of several spectacular achievements of contemporary physics, and in the last years powerful techniques have been developed allowing to put renormalization on a firm mathematical basis. This book provides a self-consistent and accessible introduction to the sophisticated tools used in the modern theory of non-perturbative renormalization, allowing an unified and rigorous treatment of Quantum Field Theory, Statistical Physics and Condensed Matter models. In particular the first part of this book is devoted to Constructive Quantum Field Theory, providing a mathematical construction of models at low dimensions and discussing the removal of the ultraviolet and infrared cut-off, the verification of the axioms and the validity of Ward Identities with the relative anomalies. The second part is devoted to lattice 2D Statistical Physics, analyzing in particular the theory of universality in perturbed Ising models and the computation of the non-universal critical indices in Vertex or Ashkin-Teller models. Finally the third part is devoted to the analysis of complex quantum fluids showing Luttinger of Fermi liquid behavior, like the 1D or 2D Hubbard model.

Providing coverage of the mathematics necessary for advanced study in physics and engineering, this text focuses on problem-solving skills and offers a vast array of exercises, as well as clearly illustrating and proving mathematical relations.

After three decades since the first nearly complete edition of John von Neumann's papers, this book is a valuable selection of those papers and excerpts of his books that are most characteristic of his activity, and reveal that of his continuous influence.The results receiving the 1994 Nobel Prizes in economy deeply rooted in Neumann's game theory are only minor traces of his exceptionally broad spectrum of creativity and stimulation.The book is organized by the specific subjects-quantum mechanics, ergodic theory, operator algebra, hydrodynamics, economics, computers, science and society. In addition, one paper which was written in German will be translated and published in English for the first time.The sections are introduced by short explanatory notes with an emphasis on recent developments based on von Neumann's contributions. An overall picture is provided by Ulam's, one of his most intimate partners in thinking, 1958 memorial lecture. Facsimilae and translations of some of his personal letters and a newly completed bibliography based on von Neumann's own careful compilation are added.

The book serves as a first introduction to computer programming of scientific applications, using the high-level Python language. The exposition is example and problem-oriented, where the applications are taken from mathematics, numerical calculus, statistics, physics, biology and finance. The book teaches "Matlab-style" and procedural programming as well as object-oriented programming. High school mathematics is a required background and it is advantageous to study classical and numerical one-variable calculus in parallel with reading this book. Besides learning how to program computers, the reader will also learn how to solve mathematical problems, arising in various branches of science and engineering, with the aid of numerical methods and programming. By blending programming, mathematics and scientific applications, the book lays a solid foundation for practicing computational science. From the reviews: Langtangen ... does an excellent job of introducing programming as a set of skills in problem solving. He guides the reader into thinking properly about producing program logic and data structures for modeling real-world problems using objects and functions and embracing the object-oriented paradigm. ... Summing Up: Highly recommended. F. H. Wild III, Choice, Vol. 47 (8), April 2010 Those of us who have learned scientific programming in Python 'on the streets' could be a little jealous of students who have the opportunity to take a course out of Langtangen's Primer." John D. Cook, The Mathematical Association of America, September 2011 This book goes through Python in particular, and programming in general, via tasks that scientists will likely perform. It contains valuable information for students new to scientific computing and would be the perfect bridge between an introduction to programming and an advanced course on numerical methods or computational science. Alex Small, IEEE, CiSE Vol. 14 (2), March /April 2012 "This fourth edition is a wonderful, inclusive textbook that covers pretty much everything one needs to know to go from zero to fairly sophisticated scientific programming in Python..." Joan Horvath, Computing Reviews, March 2015

This new edition is a concise introduction to the basic methods of computational physics. Readers will discover the benefits of numerical methods for solving complex mathematical problems and for the direct simulation of physical processes. The book is divided into two main parts: Deterministic methods and stochastic methods in computational physics. Based on concrete problems, the first part discusses numerical differentiation and integration, as well as the treatment of ordinary differential equations. This is extended by a brief introduction to the numerics of partial differential equations. The second part deals with the generation of random numbers, summarizes the basics of stochastics, and subsequently introduces Monte-Carlo (MC) methods.

Specific emphasis is on MARKOV chain MC algorithms. The final two chapters discuss data analysis and stochastic optimization. All this is again motivated and augmented by applications from physics. In addition, the book offers a number of appendices to provide the reader with information on topics not discussed in the main text. Numerous problems with worked-out solutions, chapter introductions and summaries, together with a clear and application-oriented style support the reader. Ready to use C++ codes are provided online.

Combining scientific computing methods and algorithms with modern data analysis techniques, including basic applications of compressive sensing and machine learning, this book develops techniques that allow for the integration of the dynamics of complex systems and big data. MATLAB is used throughout for mathematical solution strategies.

Non-linear stochastic systems are at the center of many engineering disciplines and progress in theoretical research had led to a better understanding of non-linear phenomena. This book provides information on new fundamental results and their applications which are beginning to appear across the entire spectrum of mechanics. The outstanding points of these proceedings are Coherent compendium of the current state of modelling and analysis of non-linear stochastic systems from engineering, applied mathematics and physics point of view. Subject areas include: Multiscale phenomena, stability and bifurcations, control and estimation, computational methods and modelling. For the Engineering and Physics communities, this book will provide first-hand information on recent mathematical developments. The applied mathematics community will benefit from the modelling and information on various possible applications.

This text is an introduction to methods of grid generation technology in scientific computing. Special attention is given to methods developed by the author for the treatment of singularly-perturbed equations, e.g. in modeling high Reynolds number flows. Functionals of conformality, orthogonality, energy and alignment are discussed.

The first book of its kind to cover a wide range of computational methods for electromagnetic phenomena, from atomistic to continuum scales, this integrated and balanced treatment of mathematical formulations, algorithms and the underlying physics enables us to engage in innovative and advanced interdisciplinary computational research.

Computational Intelligence: A Compendium presents a well structured overview about this rapidly growing field with contributions from leading experts in Computational Intelligence. The main focus of the compendium is on applied methods, tried-and-proven as being effective to realworld problems, which is especially useful for practitioners, researchers, students and also newcomers to the field. This state-of- handbook-style book has contributions by leading experts.

Now in its third edition, Mathematical Concepts in the Physical Sciences provides a comprehensive introduction to the areas of mathematical physics. It combines all the essential math concepts into one compact, clearly written reference.

This volume contains the essential mathematical tools and techniques used to solve problems in physics. A useful textbook for all serious undergraduate students of physics. This fifth edition has a new art programme throughout the book; additional new and improved exercises; updated references for computational techniques for using Numerical Recipes and Mathematica TM; and there is a reference compendium for important mathematical methods used in physics.

Help students master real-world problems as they develop new insight into the physical sciences Problems in the physical sciences that once baffled and frustrated scientists can now be solved easily with the aid of a computer. Computers can quickly complete complex calculations, provide numerical simulations of natural systems, and explore the unknown. Computational Physics shows students how to use computers to solve scientific problems and understand systems at a level previously possible only in a research environment. Adaptable to a ten-week class or a full-year course, it provides C and Fortran programs that can be modified and rewritten as needed to implement a wide range of computational projects. Light on theory, heavy on applications, this practical, easy-to-understand guide * Presents material from a problem-oriented perspective * Integrates physics, computer science, and numerical methods and statistics * Encourages creative thinking and an object-oriented view of problem solving * Provides C and Fortran programs for implementing most of the projects * Provides samples of problems actually solved in two ten-week quarters * Includes a 3.5" floppy disk containing the codes featured in the text * Offers multimedia demonstrations and updates on a complementary Web site With this engaging book as a guide, advanced undergraduates and first-year graduate students will gain confidence in their abilities and develop new insight into the physical sciences as they use their computers to address challenging and stimulating problems.

Complex Systems Science in Biomedicine Thomas S. Deisboeck and J. Yasha Kresh Complex Systems Science in Biomedicine covers the emerging field of systems science involving the application of physics, mathematics, engineering and computational methods and techniques to the study of biomedicine including nonlinear dynamics at the molecular, cellular, multi-cellular tissue, and organismic level. With all chapters helmed by leading scientists in the field, Complex Systems Science in Biomedicine's goal is to offer its audience a timely compendium of the ongoing research directed to the understanding of biological processes as whole systems instead of as isolated component parts. In Parts I & II, Complex Systems Science in Biomedicine provides a general systems thinking perspective and presents some of the fundamental theoretical underpinnings of this rapidly emerging field. Part III then follows with a multi-scaled approach, spanning from the molecular to macroscopic level, exemplified by studying such diverse areas as molecular networks and developmental processes, the immune and nervous systems, the heart, cancer and multi-organ failure. The volume concludes with Part IV that addresses methods and techniques driven in design and development by this new understanding of biomedical science. Key Topics Include: • Historic Perspectives of General Systems Thinking • Fundamental Methods and Techniques for Studying Complex Dynamical Systems • Applications from Molecular Networks to Disease Processes • Enabling Technologies for Exploration of Systems in the Life Sciences Complex Systems Science in Biomedicine is essential reading for experimental, theoretical, and interdisciplinary

scientists working in the biomedical research field interested in a comprehensive overview of this rapidly emerging field. About the Editors: Thomas S. Deisboeck is currently Assistant Professor of Radiology at Massachusetts General Hospital and Harvard Medical School in Boston. An expert in interdisciplinary cancer modeling, Dr. Deisboeck is Director of the Complex Biosystems Modeling Laboratory which is part of the Harvard-MIT Martinos Center for Biomedical Imaging. J. Yasha Kresh is currently Professor of Cardiothoracic Surgery and Research Director, Professor of Medicine and Director of Cardiovascular Biophysics at the Drexel University College of Medicine. An expert in dynamical systems, he holds appointments in the School of Biomedical Engineering and Health Systems, Dept. of Mechanical Engineering and Molecular Pathobiology Program. Prof. Kresh is Fellow of the American College of Cardiology, American Heart Association, Biomedical Engineering Society, American Institute for Medical and Biological Engineering.

The physics of plasmas is an extremely rich and complex subject as the variety of topics addressed in this book demonstrates. This richness and complexity demands new and powerful techniques for investigating plasma physics. An outgrowth from his graduate course teaching, now with corrections, Tajima's text provides not only a lucid introduction to computational plasma physics, but also offers the reader many examples of the way numerical modeling, properly handled, can provide valuable physical understanding of the nonlinear aspects so often encountered in both laboratory and astrophysical plasmas. Included here are computational methods for modern nonlinear physics as applied to hydrodynamic turbulence, solitons, fast reconnection of magnetic fields, anomalous transports, dynamics of the sun, and more. The text contains examples of problems now solved using computational techniques including those concerning finite-size particles, spectral techniques, implicit differencing, gyrokinetic approaches, and particle simulation.

This compendium is made up of a selection of the best and most representative papers from a group of Elsevier's geotechnology journals.

The ninth volume of Annual Reviews of Computational Physics has as a special feature a comprehensive compendium of interatomic potentials as used for materials properties. Other articles deal with simulations of magnetic nanostructures, improved Monte Carlo methods (e.g. for nucleation studies in Ising models), fluid dynamics with large mean free paths, the growing field of "sociophysics," and teaching of undergraduate computational physics (including an introduction to Java). Contents:Empirical Potential Energy Functions Used in the Simulations of Materials Properties (™ Erkoç)Thermally Activated Reversal in Magnetic Nanostructures (U Nowak)A Tutorial on Advanced Dynamic Monte Carlo Methods for Systems with Discrete State Spaces (M A Novotny)Beyond Navier–Stokes: Burnett Equations for Flow Simulations in the Continuum–Transition Regimes (R K Agarwal et al.)Social Impact Models of Opinion Dynamics (J A Holyst et al.)Teaching Computational Physics to Undergraduates (J Tobochnik & H Gould) Readership: Researchers in computational physics. Keywords:Teaching;Interatomic Potentials;Sociophysics;Advances Monte CarloReviews:"… the authors' comments are clearly based on experience of teaching the subject over many years and as such may well be of use to anyone planning such a course for the first time."Contemporary Physics

With contributions by leading quantum physicists, philosophers and historians, this comprehensive A-to-Z of quantum physics provides a lucid understanding of key concepts of quantum theory and experiment. It covers technical and interpretational aspects alike, and includes both traditional and new concepts, making it an indispensable resource for concise, up-to-date information about the many facets of quantum physics.

The ninth volume of Annual Reviews of Computational Physics has as a special feature a comprehensive compendium of interatomic potentials as used for materials properties. Other articles deal with simulations of magnetic nanostructures, improved Monte Carlo methods (e.g. for nucleation studies in Ising models), fluid dynamics with large mean free paths, the growing field of OC sociophysics, OCO and teaching of undergraduate computational physics (including an introduction to Java)."

Presents numerical methods and computer code in Matlab for the solution of ODEs and PDEs with detailed line-by-line discussion.

This book helps advanced undergraduate, graduate and postdoctoral students in their daily work by offering them a compendium of numerical methods. The choice of methods pays significant attention to error estimates, stability and convergence issues as well as to the ways to optimize program execution speeds. Many examples are given throughout the chapters, and each chapter is followed by at least a handful of more comprehensive problems which may be dealt with, for example, on a weekly basis in a one- or two-semester course. In these end-of-chapter problems the physics background is pronounced, and the main text preceding them is intended as an introduction or as a later reference. Less stress is given to the explanation of individual algorithms. It is tried to induce in the reader an own independent thinking and a certain amount of scepticism and scrutiny instead of blindly following readily available commercial tools.

Following up on his first book, Fundementals of Biophysics, the author, a well-known scientist in this area, builds on that foundation by offering the biologist or scientist an advanced, comprehensive coverage of biophysics. Structuring the book into four major parts, he thoroughly covers the biophysics of complex systems, such as the kinetics and thermodynamic processes of biological systems, in the first part. The second part is dedicated to molecular biophysics, such as biopolymers and proteins, and the third part is on the biophysics of membrane processes. The final part is on photobiological processes. This ambitious work is a must-have for the veteran biologist, scientist, or chemist working in this field, and for the novice or student, who is interested in learning about biophysics. It is an emerging field, becoming increasingly more important, the more we learn about and develop the science. No library on biophysics is complete without this text and its precursor, both available from Wiley-Scrivener.

Computational Methods for Microstructure-Property Relationships introduces state-of-the-art advances in computational modeling approaches for materials structure-property relations. Written with an approach that recognizes the necessity of the engineering computational mechanics framework, this volume provides balanced treatment of

heterogeneous materials structures within the microstructural and component scales. Encompassing both computational mechanics and computational materials science disciplines, this volume offers an analysis of the current techniques and selected topics important to industry researchers, such as deformation, creep and fatigue of primarily metallic materials. Researchers, engineers and professionals involved with predicting performance and failure of materials will find Computational Methods for Microstructure-Property Relationships a valuable reference.

The Compendium of Theoretical Physics contains the canonical curriculum of theoretical physics. From classical mechanics over electrodynamics, quantum mechanics and statistical physics/thermodynamics, all topics are treated axiomatic-deductively and confimed by exercises, solutions and short summaries.

Edited by internationally recognized authorities in the field, this expanded edition of the bestselling Handbook first published in 1999 is aimed at the design and operation of modern accelerators including Linacs, Synchrotrons and Storage Rings. It is intended as a vade mecum for professional engineers and physicists engaged in these subjects. With a collection of 2200 equations, 345 illustrations and 185 tables, here one will find, in addition to the common formulae of previous compilations, hard to find, specialized formulae, recipes and material data pooled from the lifetime experience of many of the world's most able practitioners of the art and science of accelerators.The eight chapters include both theoretical and practical matters as well as an extensive glossary of accelerator types. Chapters on beam dynamics and electromagnetic and nuclear interactions deals with linear and nonlinear single particle and collective effects including spin motion, beam-environment, beam-beam and intrabeam interactions. The impedance concept and calculations are dealt with at length as are the instabilities associated with the various interactions mentioned. A chapter on operational considerations deals with orbit error assessment and correction. Chapters on mechanical and electrical considerations present material data and important aspects of component design including heat transfer and refrigeration. Hardware systems for particle sources, feedback systems, confinement and acceleration (both normal conducting and superconducting) receive detailed treatment in a subsystems chapter, beam measurement techniques and apparatus being treated therein as well. The closing chapter gives data and methods for radiation protection computations as well as much data on radiation damage to various materials and devices.A detailed index is provided together with reliable references to the literature where the most detailed information available on all subjects treated can be found.

The five-volume set may serve as a comprehensive reference on electromagnetic analysis and its applications at all frequencies, from static fields to optics and photonics. The material includes micro- and nanomagnetics, the new generation of electric machines, renewable energy, hybrid vehicles, low-noise motors; antennas and microwave devices, plasmonics, metamaterials, lasers, and more.Written at a level accessible to both graduate students and engineers, Electromagnetic Analysis is a comprehensive reference, covering methods and applications at all frequencies (from statics to optical). Each volume contains pedagogical/tutorial material of high archival value as well as chapters on state-of-the-art developments.

After three decades since the first nearly complete edition of John von Neumann's papers, this book is a valuable selection of those papers and excerpts of his books that are most characteristic of his activity, and reveal that of his continuous influence. The results receiving the 1994 Nobel Prizes in economy deeply rooted in Neumann's game theory are only minor traces of his exceptionally broad spectrum of creativity and stimulation. The book is organized by the specific subjects-quantum mechanics, ergodic theory, operator algebra, hydrodynamics, economics, computers, science and society. In addition, one paper which was written in German will be translated and published in English for the first time. The sections are introduced by short explanatory notes with an emphasis on recent developments based on von Neumann's contributions. An overall picture is provided by Ulam's, one of his most intimate partners in thinking, 1958 memorial lecture. Facsimilae and translations of some of his personal letters and a newly completed bibliography based on von Neumann's own careful compilation are added. Contents:Quantum Mechanics:Mathematical Foundations of Quantum MechanicsThe Logic of Quantum Mechanics (with G Birkhoff)Ergodic Theory:Proof of the Quasi-Ergodic HypothesisOperator Methods in Classical Mechanics, II (with P R Halmos)Operator Algebra:Algebra of Functional Operations and Theory of Normal OperatorsOn Rings of Operators I–IVUse of Variational Methods in HydrodynamicsEconomics:Theory of Games and Economic Behavior (with O Morgenstern)Computers:On the Principles of Large Scale Computing Machines (with H H Goldstine)Science and Society:The MathematicianMethod in the Physical SciencesThe Role of Mathematics in the Sciences and in Societyand other papers Readership: Mathematicians. keywords:Mathematics;Science History;Computer Science;J V Neumann;Science and Society;Game Theory;Quantum Mechanics;Operator Algebra;Hydrodynamics;Ergodic Theory"The collection bears testimony to the lasting influence of John von Neumann's work on the course of modern mathematics."R Siegmund-Schultze Mathematical Abstracts "This collection is a fascinating introduction to the work of John von Neumann … it has much to offer even to the casual browser and will also be relevant and interesting to those working today in the fields on which von Neumann had such enormous influence."Mathematical Reviews

Advances in Imaging & Electron Physics merges two long-running serials--Advances in Electronics & Electron Physics and Advances in Optical & Electron Microscopy. The series features extended articles on the physics of electron devices (especially semiconductor devices), particle optics at high and low energies, microlithography, image science and digital image processing, electromagnetic wave propagation, electron microscopy, and the computing methods used in all these domains.

Building on the extensive coverage of the first volume, Volume 2 focuses on the fundamentals of measurements and computational techniques that will aid researchers in the construction and use of measurement devices.

A plain language style, worked examples and exercises help students to understand the foundations of computational physics and engineering.

This book is intended to help advanced undergraduate, graduate, and postdoctoral students in their daily work by offering them a compendium of numerical methods. The choice of methods

pays significant attention to error estimates, stability and convergence issues, as well as optimization of program execution speeds. Numerous examples are given throughout the chapters, followed by comprehensive end-of-chapter problems with a more pronounced physics background, while less stress is given to the explanation of individual algorithms. The readers are encouraged to develop a certain amount of skepticism and scrutiny instead of blindly following readily available commercial tools. The second edition has been enriched by a chapter on inverse problems dealing with the solution of integral equations, inverse Sturm-Liouville problems, as well as retrospective and recovery problems for partial differential equations. The revised text now includes an introduction to sparse matrix methods, the solution of matrix equations, and pseudospectra of matrices; it discusses the sparse Fourier, non-uniform Fourier and discrete wavelet transformations, the basics of non-linear regression and the Kolmogorov-Smirnov test; it demonstrates the key concepts in solving stiff differential equations and the asymptotics of Sturm-Liouville eigenvalues and eigenfunctions. Among other updates, it also presents the techniques of state-space reconstruction, methods to calculate the matrix exponential, generate random permutations and compute stable derivatives.

This volume, which contains 15 contributions, is based on a minicourse held at the 1987 IEEE Plasma Science Meeting. The purpose of the lectures in the course was to acquaint the students with the multidisciplinary nature of computational techniques and the breadth of research areas in plasma science in which computation can address important physics and engineering design issues. These involve: electric and magnetic fields, MHD equations, chemistry, radiation, ionization etc. The contents of the contributions, written subsequent to the minicourse, stress important aspects of computer applications. They are: 1) the numerical methods used; 2) the range of applicability; 3) how the methods are actually employed in research and in the design of devices; and, as a compendium, 4) the multiplicity of approaches possible for any one problem. The materials in this book are organized by both subject and applications which display some of the richness in computational plasma physics.