A First Course In Computational Physics

A First Course in Computational PhysicsBasic Concepts in Computational PhysicsComputational PhysicsComputational PhysicsComputational Problems for PhysicsComputational PhysicsA Survey of Computational PhysicsA First Course in Computational PhysicsAn Introduction to Computational PhysicsMethods in Computational PhysicsCOMPUTATIONAL PHYSICSApplied Computational PhysicsComputational PhysicsProgress in Computational Physics of MatterComputation in Modern PhysicsAnnual Reviews of Computational Physics IVComputational PhysicsComputational PhysicsA Computational Method in Plasma PhysicsComputational Physics Paul L. DeVries Benjamin A. Stickler Rubin H. Landau Philipp O.J. Scherer Rubin H. Landau Konstantinos N. Anagnostopoulos Rubin Landau Paul L. DeVries Tao Pang Berni Alder SUJAUL CHOWDHURY Joseph F. Boudreau R. C. Verma Luciano Reatto William R. Gibbs Dietrich Stauffer Darren Walker Philipp Scherer F. Bauer D.k. Jha
A First Course in Computational Physics Basic Concepts in Computational Physics Computational Physics Computational Physics Computational Problems for Physics Computational Physics A Survey of Computational Physics A First Course in Computational Physics An Introduction to Computational Physics Methods in Computational Physics COMPUTATIONAL PHYSICS Applied Computational Physics Computational Physics Progress in Computational Physics of Matter Computation in Modern Physics Annual Reviews of Computational Physics IV Computational Physics Computational Physics A Computational Method in Plasma Physics Computational Physics *Paul L. DeVries Benjamin A. Stickler Rubin H. Landau Philipp O.J. Scherer Rubin H. Landau Konstantinos N. Anagnostopoulos Rubin Landau Paul L. DeVries Tao Pang Berni Alder SUJAUL CHOWDHURY Joseph F. Boudreau R. C. Verma Luciano Reatto William R. Gibbs Dietrich Stauffer Darren Walker Philipp Scherer F. Bauer D.k. Jha*

computers and computation are extremely important components of physics and should be integral parts of a physicist s education furthermore computational physics is reshaping the way calculations are made in all areas of physics intended for the physics and engineering students who have completed the introductory physics

course a first course in computational physics second edition covers the different types of computational problems using matlab with exercises developed around problems of physical interest topics such as root finding newton cotes integration and ordinary differential equations are included and presented in the context of physics problems a few topics rarely seen at this level such as computerized tomography are also included within each chapter the student is led from relatively elementary problems and simple numerical approaches through derivations of more complex and sophisticated methods often culminating in the solution to problems of significant difficulty the goal is to demonstrate how numerical methods are used to solve the problems that physicists face read the review published in computing in science engineering magazine march april 2011 vol 13 no 2 2011 ieee published by the ieee computer society

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

the use of computation and simulation has become an essential part of the scientific process being able to transform a theory into an algorithm requires significant theoretical insight detailed physical and mathematical understanding and a working level of competency in programming this upper division text provides an unusually broad survey of the topics of modern computational physics from a multidisciplinary computational science point of view its philosophy

is rooted in learning by doing assisted by many model programs with new scientific materials as well as with the python programming language python has become very popular particularly for physics education and large scientific projects it is probably the easiest programming language to learn for beginners yet is also used for mainstream scientific computing and has packages for excellent graphics and even symbolic manipulations the text is designed for an upper level undergraduate or beginning graduate course and provides the reader with the essential knowledge to understand computational tools and mathematical methods well enough to be successful as part of the teaching of using computers to solve scientific problems the reader is encouraged to work through a sample problem stated at the beginning of each chapter or unit which involves studying the text writing debugging and running programs visualizing the results and the expressing in words what has been done and what can be concluded then there are exercises and problems at the end of each chapter for the reader to work on their own with model programs given for that purpose

this book encapsulates the coverage for a two semester course in computational physics the first part introduces the basic numerical methods while omitting mathematical proofs but demonstrating the algorithms by way of numerous computer experiments the second part specializes in simulation of classical and quantum systems with instructive examples spanning many fields in physics from a classical rotor to a quantum bit all program examples are realized as java applets ready to run in your browser and do not require any programming skills

our future scientists and professionals must be conversant in computational techniques in order to facilitate integration of computer methods into existing physics courses this textbook offers a large number of worked examples and problems with fully guided solutions in python as well as other languages mathematica java c fortran and maple it s also intended as a self study guide for learning how to use computer methods in physics the authors include an introductory chapter on numerical tools and indication of computational and physics difficulty level for each problem readers also benefit from the following features detailed explanations and solutions in various coding languages problems are ranked based on computational and physics difficulty basics of numerical methods covered in an introductory chapter programming guidance via

flowcharts and pseudocode rubin landau is a distinguished professor emeritus in the department of physics at oregon state university in corvallis and a fellow of the american physical society division of computational physics manuel jose paez mejia is a professor of physics at universidad de antioquia in medellín colombia

this book is an introduction to the computational methods used in physics and other scientific fields it is addressed to an audience that has already been exposed to the introductory level of college physics usually taught during the first two years of an undergraduate program in science and engineering the book starts with very simple problems in particle motion and ends with an in depth discussion of advanced techniques used in monte carlo simulations in statistical mechanics the level of instruction rises slowly while discussing problems like the diffusion equation electrostatics on the plane quantum mechanics and random walks the book aims to provide the students with the background and the experience needed in order to advance to high performance computing projects in science and engineering but it also tries to keep the students motivated by considering interesting applications in physics like chaos quantum mechanics special relativity and the physics of phase transitions the book and the accompanying software is available for free in electronic form at goo gl sguekm physics ntua gr 7ekonstant computationalphysics and a printed copy can be purchased from lulu com at goo gl pg1zhc vol i and goo gl xssbdp vol ii

computational physics is a rapidly growing subfield of computational science in large part because computers can solve previously intractable problems or simulate natural processes that do not have analytic solutions the next step beyond landau s first course in scientific computing and a follow up to landau and páez s computational physics this text presents a broad survey of key topics in computational physics for advanced undergraduates and beginning graduate students including new discussions of visualization tools wavelet analysis molecular dynamics and computational fluid dynamics by treating science applied mathematics and computer science together the book reveals how this knowledge base can be applied to a wider range of real world problems than computational physics texts normally address designed for a one or two semester course a survey of computational physics will also interest anyone who wants a reference on or practical experience in the basics of computational physics accessible to advanced undergraduates real world problem

solving approach java codes and applets integrated with text companion site includes videos of lectures

thoroughly revised for its second edition this advanced textbook provides an introduction to the basic methods of computational physics and an overview of progress in several areas of scientific computing by relying on free software available from cern the book begins by dealing with basic computational tools and routines covering approximating functions differential equations spectral analysis and matrix operations important concepts are illustrated by relevant examples at each stage the author also discusses more advanced topics such as molecular dynamics modeling continuous systems monte carlo methods genetic algorithm and programming and numerical renormalization it includes many more exercises this can be used as a textbook for either undergraduate or first year graduate courses on computational physics or scientific computation it will also be a useful reference for anyone involved in computational research

the aim of the book computational physics is to serve as textbook on applied computational physics contents of this book together with those of 7 monographs of the author listed in the references form a coherent course text i e lecture notes for a 2 semester course for final year undergraduate students of physics and mathematics major for the course titled computational physics instead of solving problems of unphysical numerical analysis this book illustrates use of different computational methods by solving problems of physics and mathematical physics for example root finding methods have been illustrated by calculating bound state energy of quantum well this is the 1st mathematica based textbook titled computational physics every computational method considered has been illustrated by thoroughly worked out exercise this pedagogical feature of the book is very important the book has been designed for use in classroom as well as in computational physics lab

a textbook that addresses a wide variety of problems in classical and quantum physics modern programming techniques are stressed throughout along with the important topics of encapsulation polymorphism and object oriented design scientific problems are physically motivated solution strategies are developed and explicit code is presented

personal computers have become an essential part of the physics curricula and is becoming an increasingly important tool in the

training of students the present book is an effort to provide a quality and classroom tested resource material salient features topics have been carefully selected to give a flavour of computational techniques in the context of a wide range of physics problems style of presentation emphasis the pedagogic approach assuming no previous knowledge of either programming in high level language or numerical techniques profusely illustrated with diagrams graphic outputs programming hints algorithms and source codes ideally suited for self study with a pc on desktop accompanied with a cd rom with source codes of selected problems saving the user from typing in the source code can be adopted as a two semester course in universities running courses such as computer applications in physics numerical methods in physics or as an additional optional paper in nodal centres of computer applications provided by ugc in different universities meets the requirements of students of physics at undergraduate and post graduate level in particular and physical sciences engineering and mathematics students in general this book is an outcome of a book project granted by university grants commission new delhi india

the aim of the book is to describe some of the recent advances through computer simulation in a broad sense in the understanding of the complex processes occurring in solids and liquids the rapid growth of computer power including the new parallel processors has stimulated a ferment of new theoretical and computational ideas which have been developed in particular by the authors in a pluriennal research project supported by consiglio nazionale delle ricerche cnr for the development of novel software for large scale computations the book will cover advances in ab initio car parrinello molecular dynamics quantum monte carlo simulations self consistent density functional computation of electronic states classical molecular dynamics simulation of thermodynamic processes chemical reactions and transport properties besides the description of the results of these techniques in leading edge applications the book will address specific aspects of the algorithms and software which have been developed by the authors in order to implement in an efficient way the new theoretical advances in these computationally intensive problems these aspects which are generally not discussed in any detail in the literature can be of great help for newcomers in the field

the use of computers to solve modern scientific problems is very

widespread the impact of the improvement of our techniques for the solution of complex problems is difficult to overstate even our approach to most problems has been changed solutions to problems once thought intractable are being routinely secured instead of using oversimplified models as has been the practice for the treatment of scientific systems in the past the entire problem can now be attacked the second edition of computation in modern physics develops and presents algorithms for the solution of many types of mathematical systems some dating as far as the last few centuries but also quite a number that have been developed within the last 10 50 years in this last category close attention is paid to the rapidly developing area of monte carlo techniques where new conceptual views of physics problems are being brought into play with this method problems in a large number of dimensions can be solved through the introduction of a modern method for the representation of multidimensional functions this book is suitable for two different levels in computational physics the first part is an advanced introductory level and is appropriate for good students with no previous experience in computational methods or any student with some experience here the student is introduced to integral and differential techniques monte carlo integration basic computer architecture methods of linear algebra finite element techniques digital signal processing and chaos the second part of the book is more specialized for problems in strong interaction with emphasis on solutions to many body scattering problems andseveral body bound state calculations with monte carlo techniques it also contains a chapter dealing with techniques for the summation of divergent series

quantum phenomena and methods are the core of this volume in our series which publishes rapidly reviews of topics in computational physics in addition we look at phase transitions in ising lattices in continuum fluids polymer solutions and end with biological ageing as before papers were submitted by e mail and these files were used directly to produce the book for increased speed and reliability

this book is designed to provide the reader with a grounding in scientific programming and computational physics it contains many exercises developed in the context of physics problems and several examples of working programs to provide a solid basis on which to build computers are now ubiquitous and are an essential tool to any would be scientific researcher computers can be used for a wide variety of scientific tasks from the simple manipulation of data to

simulations of real world events the book intends to give the reader the confidence to start applying the methods presented to their own problems and research it covers topics such as interpolation integration and the numerical solutions to both ordinary and partial differential equations it discusses simple ideas such as linear interpolation and root finding through bisection to more advanced concepts such as the gauss legendre quadrature and the runge kutta fehlberg algorithm to solve complex differential equations it also contains a chapter on high performance computing that provides an introduction to parallel programming features designed to provide the reader with a grounding in scientific programming and computational physics contains many exercises developed in the context of physics problems and several examples of working programs to provide a solid basis on which to build

this textbook presents basic and advanced computational physics in a very didactic style it contains very well presented and simple mathematical descriptions of many of the most important algorithms used in computational physics the first part of the book discusses the basic numerical methods the second part concentrates on simulation of classical and quantum systems several classes of integration methods are discussed including not only the standard euler and runge kutta method but also multi step methods and the class of verlet methods which is introduced by studying the motion in liouville space a general chapter on the numerical treatment of differential equations provides methods of finite differences finite volumes finite elements and boundary elements together with spectral methods and weighted residual based methods the book gives simple but non trivial examples from a broad range of physical topics trying to give the reader insight into not only the numerical treatment but also simulated problems different methods are compared with regard to their stability and efficiency the exercises in the book are realised as computer experiments

in this book we report on research in methods of computational magneto hydrodynamics supported by the united states department of energy under contract ey 76 c 02 3077 with new york university the work has re sulted in a computer code for mathematical analysis of the equilibrium and stability of a plasma in three dimensions with toroidal geometry but no sym metry the code is listed in the final chapter versions of it have been used for the design of experiments at the los alamos scientific laboratory and the max planck institute

for plasma physics in garching we are grateful to daniel barnes jeremiah brackbill harold grad william grossmann abraham kadish peter lax guthrie miller arnulf schliiter and harold weitzner for many useful discussions of the theory we are especially indebted to franz herrnegger for theoretical and pedagogical comments constance engle has provided outstanding assistance with the typescript we take pleasure in acknowledging the help of the staff of the courant mathematics and com puting laboratory at new york university in particular we should like to express our thanks to max goldstein kevin mcauliffe terry moore toshi nagano and tsun tam frances bauer new york octavio betancourt september 1978 paul garabedian v contents chapter 1 introduction 1 1 1 formulation of the problem 1 1 2 discussion of results 2 chapter 2 the variational principle 4 4 2 1 the magnetostatic equations 6 2 2 flux constraints in the plasma 7 2 3 the ergodic constraint

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