Volume 33

Avner Friedman

Mathematics in Industrial Problems

Part 4

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Mathematics In Industrial Problems Part 4

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Mathematics In Industrial Problems Part 4:

Mathematics in Industrial Problems Avner Friedman,2012-12-06 This is the fourth volume in the series Mathematics in Industrial Prob lems The motivation for these volumes is to foster interaction between Industry and Mathematics at the grass roots that is at the level of spe cific problems These problems come from Industry they arise from models developed by the industrial scientists in ventures directed at the manufac ture of new or improved products At the same time these problems have the potential for mathematical challenge and novelty To identify such problems I have visited industries and had discussions with their scientists Some of the scientists have subsequently presented their problems in the IMA Seminar on Industrial Problems The book is based on questions raised in the seminar and subsequent discussions Each chapter is devoted to one of the talks and is self contained The chap ters usually provide references to the mathematical literature and a list of open problems which are of interest to the industrial scientists For some problems partial solution is indicated briefly The last chapter of the book contains a short description of solutions to some of the problems raised in the third volume as well as references to papers in which such solutions have been published *Mathematics in Industrial Problems* Avner Friedman,2012-12-06 This is the eighth volume in the series Mathematics in Industrial Prob lems The motivation for these volumes is to foster interaction between Industry and Mathematics at the grass roots level that is at the level of specific problems These problems come from Industry they arise from models developed by the industrial scientists in ventures directed at the manufacture of new or improved products At the same time these prob lems have the potential for mathematical challenge and novelty To identify such problems I have visited industries and had discussions with their scientists Some of the scientists have subsequently presented their problems in the IMA Seminar on Industrial Problems The book is based on the seminar presentations and on questions raised in subsequent discussions Each chapter is devoted to one of the talks and is self contained The chapters usually provide references to the mathematical literature and a list of open problems that are of interest to industrial scientists For some problems a partial solution is indicated briefly The last chapter of the book contains a short description of solutions to some of the problems raised in the previous volume as well as references to papers in which such solutions have been published **Mathematical Models for Biological Pattern Formation** Philip K. Maini,Hans G. Othmer,2012-12-06 This 121st IMA volume entitled MATHEMATICAL MODELS FOR BIOLOGICAL PATTERN FORMATION is the first of a new series called FRONTIERS IN APPLICATION OF MATHEMATICS The FRONTIERS volumes are motivated by IMA pro grams and workshops but are specially planned and written to provide an entree to and assessment of exciting new areas for the application of mathematical tools and analysis The emphasis in FRONTIERS volumes is on surveys exposition and outlook to attract more mathematicians and other scientists to the study of these areas and to focus efforts on the most important issues rather than papers on the most recent research results aimed at an audience of specialists The present volume of peer reviewed papers grew out of the 1998 99 IMA program on

Mathematics in Biology in particular the Fall 1998 em phasis on Theoretical Problems in Developmental Biology and Immunol ogy During that period there were two workshops on Pattern Formation and Morphogenesis organized by Professors Murray Maini and Othmer James Murray was one of the principal organizers for the entire year pro gram I am very grateful to James Murray for providing an introduction and to Philip Maini and Hans Othmer for their excellent work in planning and preparing this first FRONTIERS volume I also take this opportunity to thank the National Science Foundation whose financial support of the IMA made the Mathematics in Biology pro gram possible Wave Propagation in Complex Media George Papanicolaou,2012-12-06 This IMA Volume in Mathematics and its Applications WAVE PROPAGATION IN COMPLEX MEDIA is based on the proceedings of two workshops Wavelets multigrid and other fast algorithms multipole FFT and their use in wave propagation and Waves in random and other complex media Both workshops were integral parts of the 1994 1995 IMA program on Waves and Scattering We would like to thank Gregory Beylkin Robert Burridge Ingrid Daubechies Leonid Pastur and George Papanicolaou for their excellent work as organizers of these meetings We also take this opportunity to thank the National Science Foun dation NSF the Army Research Office ARO and the Office of Naval Research ONR whose financial support made these workshops possible A vner Friedman Robert Gulliver v PREFACE During the last few years the numerical techniques for the solution of elliptic problems in potential theory for example have been drastically improved Several so called fast methods have been developed which re duce the required computing time many orders of magnitude over that of classical algorithms The new methods include multigrid fast Fourier transforms multi pole methods and wavelet techniques Wavelets have re cently been developed into a very useful tool in signal processing the solu tion of integral equation etc Wavelet techniques should be quite useful in many wave propagation problems especially in inhomogeneous and nonlin ear media where special features of the solution such as singularities might be tracked efficiently **Parallel Solution of Partial Differential Equations** Petter Bjorstad,Mitchell Luskin,2012-12-06 This IMA Volume in Mathematics and its Applications PARALLEL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS is based on the proceedings of a workshop with the same title The work shop was an integral part of the 1996 97IMA program on MATHEMAT ICS IN HIGH PERFORMANCE COMPUTING I would like to thank Petter Bj0rstad of the Institutt for Informatikk University of Bergen and Mitchell Luskin of the School of Mathematics University of Minnesota for their excellent work as organizers of the meeting and for editing the proceedings I also take this opportunity to thank the National Science Founda tion NSF Department of Energy DOE and the Army Research Office ARO whose financial support made the workshop possible Willard Miller Jr Professor and Director v PREFACE The numerical solution of partial differential equations has been of major importance to the development of many technologies and has been the target of much of the development of parallel computer hardware and software Parallel computers offer the promise of greatly increased perfor mance and the routine calculation of previously intractable problems The papers in this volume were presented at the IMA workshop on the Paral lel Solution of PDE held

during June 9 13 1997 The workshop brought together leading numerical analysts computer scientists and engineers to assess the state of the art and to consider future directions **Diagnosis and Prediction** Seymour Geisser,2012-12-06 This IMA Volume in Mathematics and its Applications DIAGNOSIS AND PREDICTION is one of the series based on the proceedings of a very successful 1997 IMA Summer Program on Statistics in the Health Sciences I would like to thank Seymour Geisser of University of Minnesota School of Statistics for his excellent work as organizer of the meeting and for editing the proceedings I am grateful to Donald A Berry Duke Uni versity Statistics Patricia Grambsch University of Minnesota Biostatis tics Joel Greenhouse Carnegie Mellon University Statistics Nicholas Lange Harvard Medical School Brain Imaging Center McLean Hospital Barry Margolin University of North Carolina Chapel Hill Biostatistics Sandy Weisberg University of Minnesota Statistics Scott Zeger Johns Hopkins University Biostatistics and Marvin Zelen Harvard School of Public Health Biostatistics for organizing the six weeks summer program I also take this opportunity to thank the National Science Foundation NSF and the Army Research Office ARO whose financial support made the workshop possible Willard Miller Jr Professor and Director v PREFACE This volume contains refereed papers submitted by participants of the third week of a six week workshop on Statistics in the Health Sciences held by the Institute of Mathematics and its Applications in Minneapolis Minnesota during July of 1997 This week was devoted to the closely related topics of Diagnosis and Prediction

Evolutionary Algorithms Lawrence D. Davis,Kenneth De Jong,Michael D. Vose,L.Darrell Whitley,2012-12-06 This IMA Volume in Mathematics and its Applications EVOLUTIONARY ALGORITHMS is based on the proceedings of a workshop that was an integral part of the 1996 97 IMA program on MATHEMATICS IN HIGH PERFORMANCE COMPUTING I thank Lawrence David Davis Tica Associates Kenneth De Jong Computer Science George Mason University Michael D Vose Computer Science The University of Tennessee and L Darrell Whitley Computer Science Colorado State University for their excellent work in organizing the workshop and for editing the proceedings Further appreciation is ex tended to Donald G Truhlar Chemistry and Supercomputing Institute University of Minnesota who was also one of the workshop organizers In addition I also take this opportunity to thank the National Science Foundation NSF Minnesota Supercomputing Institute MSI and the Army Research Office ARO whose financial support made the workshop possible Willard Miller Jr Professor and Director v PREFACE The IMA Workshop on Evolutionary Algorithms brought together many of the top researchers working in the area of Evolutionary Com putation for a week of intensive interaction The field of Evolutionary Computation has developed significantly over the past 30 years and today consists a variety of subfields such as genetic algorithms evolution strate gies evolutionary programming and genetic programming each with their own algorithmic perspectives and goals

Stochastic Models in Geosystems Stanislav A. Molchanov,Wojbor A. Woyczynski,2012-12-06 This IMA Volume in Mathematics and its Applications STOCHASTIC MODELS IN GEOSYSTEMS is based on the proceedings of a workshop with the same title and was an integral part of the 1993 94 IMA program on Emerging Applications of Probability We would like to

thank Stanislav A Molchanov and Wojbor A Woyczynski for their hard work in organizing this meeting and in edit ing the proceedings We also take this opportunity to thank the National Science Foundation the Office of N aval Research the Army Research Of fice and the National Security Agency whose financial support made this workshop possible A vner Friedman Willard Miller Jr v PREFACE A workshop on Stochastic Models in Geosystems was held during the week of May 16 1994 at the Institute for Mathematics and Its Applica tions at the University of Minnesota It was part of the Special Year on Emerging Applications of Prob ability program put together by an organiz ing committee chaired by J Michael Steele The invited speakers represented a broad interdisciplinary spectrum including mathematics statistics physics geophysics astrophysics atmo spheric physics fluid mechanics seismology and oceanography The com mon underlying theme was stochastic modeling of geophysical phenomena and papers appearing in this volume reflect a number of research directions that are currently pursued in these areas **Mathematical Approaches to Biomolecular Structure and Dynamics** Jill P. Mesirov,Klaus Schulten,De Witt Sumners,2012-12-06 This IMA Volume in Mathematics and its Applications MATHEMATICAL APPROACHES TO BIOMOLECULAR STRUCTURE AND DYNAMICS is one of the two volumes based on the proceedings of the 1994 IMA Sum mer Program on Molecular Biology and comprises Weeks 3 and 4 of the four week program Weeks 1 and 2 appeared as Volume 81 Genetic Mapping and DNA Sequencing We thank Jill P Mesirov Klaus Schulten and De Witt Sumners for organizing Weeks 3 and 4 of the workshop and for editing the proceedings We also take this opportunity to thank the National Institutes of Health NIH National Center for Human Genome Research the National Science Foundation NSF Biological Instrumen tation and Resources and the Department of Energy DOE whose fi nancial support made the summer program possible A vner Friedman Robert Gulliver v PREFACE The revolutionary progress in molecular biology within the last 30 years opens the way to full understanding of the molecular structures and mech anisms of living organisms Interdisciplinary research in mathematics and molecular biology is driven by ever growing experimental theoretical and computational power The mathematical sciences accompany and support much of the progress achieved by experiment and computation as well as provide insight into geometric and topological properties of biomolecular structure and processes This volume consists of a representative sample of the papers presented during the last two weeks of the month long Institute for Mathematics and Its Applications Summer 1994 Program in Molecular Biology *Topology and Geometry in Polymer Science* Stuart G. Whittington,Witt De Sumners,Timothy Lodge,2012-12-06 This IMA Volume in Mathematics and its Applications TOPOLOGY AND GEOMETRY IN POLYMER SCIENCE is based on the proceedings of a very successful one week workshop with the same title This workshop was an integral part of the 1995 1996 IMA program on Mathematical Methods in Materials Science We would like to thank Stuart G Whittington De Witt Sumners and Timothy Lodge for their excellent work as organizers of the meeting and for editing the proceedings We also take this opportunity to thank the National Science Foun dation NSF the Army Research Office ARO and the Office of Naval Research ONR whose financial support made the

workshop possible A vner Friedman Robert Gulliver v PREFACE This book is the product of a workshop on Topology and Geometry of Polymers held at the IMA in June 1996 The workshop brought together topologists combinatorialists theoretical physicists and polymer scientists who share an interest in characterizing and predicting the microscopic en tanglement properties of polymers and their effect on macroscopic physical properties *Mathematical Approaches for Emerging and Reemerging Infectious Diseases: Models, Methods, and Theory* Carlos Castillo-Chavez,Sally Blower,Pauline van den Driessche,Denise Kirschner,Abdul-Aziz Yakubu,2012-12-06 This IMA Volume in Mathematics and its Applications MATHEMATICAL APPROACHES FOR EMERGING AND REEMERGING INFECTIOUS DISEASES MODELS AND THEORY METHODS is based on the proceedings of a successful one week workshop The pro ceedings of the two day tutorial which preceded the workshop Introduction to Epidemiology and Immunology appears as IMA Volume 125 Math ematical Approaches for Emerging and Reemerging Infectious Diseases An Introduction The tutorial and the workshop are integral parts of the September 1998 to June 1999 IMA program on MATHEMATICS IN BI OLOGY I would like to thank Carlos Castillo Chavez Director of the Math ematical and Theoretical Biology Institute and a member of the Depart ments of Biometrics Statistics and Theoretical and Applied Mechanics Cornell University Sally M Blower Biomathematics UCLA School of Medicine Pauline van den Driessche Mathematics and Statistics Uni versity of Victoria and Denise Kirschner Microbiology and Immunology University of Michigan Medical School for their superb roles as organizers of the meetings and editors of the proceedings Carlos Castillo Chavez es pecially made a major contribution by spearheading the editing process I am also grateful to Kenneth L Cooke Mathematics Pomona College for being one of the workshop organizers and to Abdul Aziz Yakubu Mathe matics Howard University for serving as co editor of the proceedings I thank Simon A Levin Ecology and Evolutionary Biology Princeton Uni versity for providing an introduction *Atmospheric Modeling* David P. Chock,Gregory R. Carmichael,2002-07-31 This volume contains refereed papers submitted by international experts who participated in the Atmospheric Modeling workshop March 15 19 2000 at the Institute for Mathematics and Its Applications IMA at the University of Minnesota The papers cover a wide range of topics presented in the workshop In particular mathematical topics include a performance comparison of operator splitting and non splitting methods time stepping methods to preserve positivity and consideration of multiple timescale issues in the modeling of atmospheric chemistry a fully 3D adaptive grid method impact of rid resolution on model predictions testing the robustness of different flow fields modeling and numerical methods in four dimensional variational data assimilation and parallel computing Modeling topics include the development of an efficient self contained global circulation chemistry transport model and its applications the development of a modal aerosol model and the modeling of the emissions and chemistry of monoterpenes that lead to the formation of secondary organic aerosols The volume provides an excellent cross section of current research activities in atmospheric modeling *Fractals in Multimedia* Michael F. Barnsley,Dietmar Saupe,Edward R. Vrscay,2012-12-06 This IMA Volume in

Mathematics and its Applications FRACTALS IN MULTIMEDIA is a result of a very successful three day minisymposium on the same title The event was an integral part of the IMA annual program on Mathemat ics in Multimedia 2000 2001 We would like to thank Michael F Barnsley Department of Mathematics and Statistics University of Melbourne Di etmar Saupe Institut fUr Informatik UniversiUit Leipzig and Edward R Vrscay Department of Applied Mathematics University of Waterloo for their excellent work as organizers of the meeting and for editing the proceedings We take this opportunity to thank the National Science Foundation for their support of the IMA Series Editors Douglas N Arnold Director of the IMA Fadil Santosa Deputy Director of the IMA v PREFACE This volume grew out of a meeting on Fractals in Multimedia held at the IMA in January 2001 The meeting was an exciting and intense one focused on fractal image compression analysis and synthesis iterated function systems and fractals in education The central concerns of the meeting were to establish within these areas where we are now and to develop a vision for the future Industrial Mathematics Avner Friedman,Walter Littman,1994-01-01 Computer Applications Physical Sciences and Engineering Variational and Free Boundary Problems Avner Friedman,Joel Spruck,2012-12-06 This IMA Volume in Mathematics and its Applications VARIATIONAL AND FREE BOUNDARY PROBLEMS is based on the proceedings of a workshop which was an integral part of the 1990 91 IMA program on Phase Transitions and Free Boundaries The aim of the workshop was to highlight new methods directions and problems in variational and free boundary theory with a concentration on novel applications of variational methods to applied problems We thank R Fosdick M E Gurtin W M Ni and L A Peletier for organizing the year long program and especially J Sprock for co organizing the meeting and co editing these proceedings We also take this opportunity to thank the National Science Foundation whose financial support made the workshop possible Avner Friedman Willard Miller Jr PREFACE In a free boundary one seeks to find a solution u to a partial differential equation in a domain a part r of its boundary of which is unknown Thus both u and r must be determined In addition to the standard boundary conditions on the un known domain an additional condition must be prescribed on the free boundary A classical example is the Stefan problem of melting of ice here the temperature sat isfies the heat equation in the water region and yet this region itself or rather the ice water interface is unknown and must be determined together with the tempera ture within the water Some free boundary problems lend themselves to variational formulation Combinatorial and Graph-Theoretical Problems in Linear Algebra Richard A. Brualdi,Shmuel Friedland,Victor Klee,2012-12-06 This IMA Volume in Mathematics and its Applications COMBINATORIAL AND GRAPH THEORETICAL PROBLEMS IN LINEAR ALGEBRA is based on the proceedings of a workshop that was an integral part of the 1991 92 IMA program on Applied Linear Algebra We are grateful to Richard Brualdi George Cybenko Alan George Gene Golub Mitchell Luskin and Paul Van Dooren for planning and implementing the year long program We especially thank Richard Brualdi Shmuel Friedland and Victor Klee for organizing this workshop and editing the proceedings The financial support of the National Science Foundation made the workshop possible A vner Friedman Willard Miller Jr

PREFACE The 1991 1992 program of the Institute for Mathematics and its Applications IMA was Applied Linear Algebra As part of this program a workshop on Com binatorial and Graph theoretical Problems in Linear Algebra was held on November 11 15 1991 The purpose of the workshop was to bring together in an informal setting the diverse group of people who work on problems in linear algebra and matrix theory in which combinatorial or graph theoretic analysis is a major com ponent Many of the participants of the workshop enjoyed the hospitality of the IMA for the entire fall quarter in which the emphasis was discrete matrix analysis Discrete Event Systems, Manufacturing Systems, and Communication Networks P.R. Kumar,P.P. Varaiya,2012-12-06 This IMA Volume in Mathematics and its Applications DISCRETE EVENT SYSTEMS MANUFACTURING SYSTEMS AND COMMUNICATION NETWORKS is based on the proceedings of a workshop that was an integral part of the 1992 93 IMA program on Control Theory The study of discrete event dynamical systems DEDS has become rapidly popular among researchers in systems and control in communication networks in manufacturing and in distributed computing This development has created problems for re searchers and potential consumers of the research The first problem is the veritable Babel of languages formalisms and approaches which makes it very difficult to determine the commonalities and distinctions among the competing schools of approaches The second related problem arises from the different traditions paradigms values and experience that scholars bring to their study of DEDS depending on whether they come from control com munication computer science or mathematical logic As a result intellectual exchange among scholars becomes compromised by unexplicated assumptions The purpose of the Workshop was to promote exchange among scholars representing some of the major schools of thought in DEDS with the hope that 1 greater clarity will be achieved thereby and 2 cross fertilization will lead to more fruitful questions We thank P R Kumar and P P Varaiya for organizing the workshop and editing the proceedings We also take this opportunity to thank the National Science Foundation and the Army Research Office whose financial support made the workshop possible A vner Friedman Willard Miller Jr **Control and Optimal Design of Distributed Parameter Systems** John E. Lagnese,David L. Russell,Luther W. White,2012-12-06 The articles in this volume focus on control theory of systems governed by nonlinear linear partial differential equations identification and optimal design of such systems and modelling of advanced materials Optimal design of systems governed by PDEs is a relatively new area of study now particularly relevant because of interest in optimization of fluid flow in domains of variable configuration advanced and composite materials studies and smart materials which include possibilities for built in sensing and control actuation The book will be of interest to both applied mathematicians and to engineers **Recent Advances in Iterative Methods** Gene Golub,Anne Greenbaum,Mitchell Luskin,2012-12-06 This IMA Volume in Mathematics and its Applications RECENT ADVANCES IN ITERATIVE METHODS is based on the proceedings of a workshop that was an integral part of the 1991 92 IMA program on Applied Linear Algebra Large systems of matrix equations arise frequently in applications and they have the prop erty that they are sparse and or structured The purpose of this workshop was to bring

together researchers in numerical analysis and various ap plication areas to discuss where such problems arise and possible meth ods of solution The last two days of the meeting were a celebration dedicated to Gene Golub on the occasion of his sixtieth birthday with the program arranged by Jack Dongarra and Paul van Dooren We are grateful to Richard Brualdi George Cybenko Alan George Gene Golub Mitchell Luskin and Paul Van Dooren for planning and implementing the year long program We especially thank Gene Golub Anne Greenbaum and Mitchell Luskin for organizing this workshop and editing the proceed ings The financial support of the National Science Foundation and the Min nesota Supercomputer Institute made the workshop possible A vner Friedman Willard Miller Jr xi PREFACE The solution of very large linear algebra problems is an integral part of many scientific computations **Linear Algebra, Markov Chains, and Queueing Models** Carl D. Meyer,Robert J. Plemmons,2012-12-06 This IMA Volume in Mathematics and its Applications LINEAR ALGEBRA MARKOV CHAINS AND QUEUEING MODELS is based on the proceedings of a workshop which was an integral part of the 1991 92 IMA program on Applied Linear Algebra We thank Carl Meyer and R J Plemmons for editing the proceedings We also take this opportunity to thank the National Science Founda tion whose financial support made the workshop possible A vner Friedman Willard Miller Jr xi PREFACE This volume contains some of the lectures given at the workshop Lin ear Algebra Markov Chains and Queueing Models held January 13 17 1992 as part of the Year of Applied Linear Algebra at the Institute for Mathematics and its Applications Markov chains and queueing models play an increasingly important role in the understanding of complex systems such as computer communi cation and transportation systems Linear algebra is an indispensable tool in such research and this volume collects a selection of important papers in this area The articles contained herein are representative of the underlying purpose of the workshop which was to bring together practitioners and re searchers from the areas of linear algebra numerical analysis and queueing theory who share a common interest of analyzing and solving finite state Markov chains The papers in this volume are grouped into three major categories perturbation theory and error analysis iterative methods and applications regarding queueing models

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