

Engineering Mathematics Through Applications Solutions

Rattan and Klingbeil's Introductory Mathematics for Engineering Applications is designed to help improve engineering student success through application-driven, just-in-time engineering math instruction. Intended to be taught by engineering faculty rather than math faculty, the text emphasizes using math to solve engineering problems instead of focusing on derivations and theory. This text implements an applied approach to teaching math concepts that are essential to introductory engineering courses that has been proven to improve the retention of students in engineering majors from the first to second year and beyond. Now in its eighth edition, Higher Engineering Mathematics has helped thousands of students succeed in their exams. Theory is kept to a minimum, with the emphasis firmly placed on problem-solving skills, making this a thoroughly practical introduction to the advanced engineering mathematics that students need to master. The extensive and thorough topic coverage makes this an ideal text for upper-level vocational courses and for undergraduate degree courses. It is also supported by a fully updated companion website with resources for both students and lecturers. It has full solutions to all 2,000 further questions contained in the 277 practice exercises.

A practical introduction to the core mathematics required for engineering study and practice Now in its seventh edition, Engineering Mathematics is an established textbook that has helped thousands of students to succeed in their exams. John Bird's approach is based on worked examples and interactive problems. This makes it ideal for students from a wide range of academic backgrounds as the student can work through the material at their own pace. Mathematical theories are explained in a straightforward manner, being supported by practical engineering examples and applications in order to ensure that readers can relate theory to practice. The extensive and thorough topic coverage makes this an ideal text for a range of Level 2 and 3 engineering courses. This title is supported by a companion website with resources for both students and lecturers, including lists of essential formulae, multiple choice tests, full solutions for all 1,800 further questions contained within the practice exercises, and biographical information on the 24 famous mathematicians and engineers referenced throughout the book. The companion website for this title can be accessed from www.routledge.com/cw/bird

A revision of the market leader, Kreyszig is known for its comprehensive coverage, careful and correct mathematics, outstanding exercises, helpful worked examples, and self-contained subject-matter parts for maximum teaching flexibility. The new edition provides invitations - not requirements - to use technology, as well as new conceptual problems, and new projects that focus on writing and working in teams.

Engineering Mathematics with Examples and Applications provides a compact and concise primer in the field, starting with the foundations, and then gradually developing to the advanced level of mathematics that is necessary for all engineering disciplines. Therefore, this book's aim is to help undergraduates rapidly develop the fundamental knowledge of engineering mathematics. The book can also be used by graduates to review and refresh their mathematical skills. Step-by-step worked examples will help the students gain more insights and build sufficient confidence in engineering mathematics and problem-solving. The main approach and style of this book is informal, theorem-free, and practical. By using an informal and theorem-free approach, all fundamental mathematics topics required for engineering are covered, and readers can gain such basic knowledge of all important topics without worrying about rigorous (often boring) proofs. Certain rigorous proof and derivatives are presented in an informal way by direct, straightforward mathematical operations and calculations, giving students the same level of fundamental knowledge without any tedious steps. In addition, this practical approach provides over 100 worked examples so that students can see how each step of mathematical problems can be derived without any gap or jump in steps. Thus, readers can build their understanding and mathematical confidence gradually and in a step-by-step manner. Covers fundamental engineering topics that are presented at the right level, without worry of rigorous proofs Includes step-by-step worked examples (of which 100+ feature in the work) Provides an emphasis on numerical methods, such as root-finding algorithms, numerical integration, and numerical methods of differential equations Balances theory and practice to aid in practical problem-solving in various contexts and applications

Engineering Mathematics Through Applications Macmillan International Higher Education

Studying engineering, whether it is mechanical, electrical or civil relies heavily on an understanding of mathematics. This new textbook clearly demonstrates the relevance of mathematical principles and shows how to apply them to solve real-life engineering problems. It deliberately starts at an elementary level so that students who are starting from a low knowledge base will be able to quickly get up to the level required. Students who have not studied mathematics for some time will find this an excellent refresher. Each chapter starts with the basics before gently increasing in complexity. A full outline of essential definitions, formulae, laws and procedures are introduced before real world situations, practicals and problem solving demonstrate how the theory is applied. Focusing on learning through practice, it contains examples, supported by 1,600 worked problems and 3,000 further problems contained within exercises throughout the text. In addition, 34 revision tests are included at regular intervals. An interactive companion website is also provided containing 2,750 further problems with worked solutions and instructor materials

This book is designed to serve as a core text for courses in advanced engineering mathematics required by many engineering departments. The style of presentation is such that the student, with a minimum of assistance, can follow the step-by-step derivations. Liberal use of examples and homework problems aid the student in the study of the topics presented. Ordinary differential equations, including a number of physical applications, are reviewed in Chapter One. The use of series methods are presented in Chapter Two, Subsequent chapters present Laplace transforms, matrix theory and applications, vector analysis, Fourier series and transforms, partial differential equations, numerical methods using finite differences, complex variables, and wavelets. The material is presented so that four or five subjects can be covered in a single course, depending on the topics chosen and the completeness of coverage. Incorporated in this textbook is the use of certain computer software packages. Short tutorials on Maple, demonstrating how problems in engineering mathematics can be solved with a computer algebra system, are included in most sections of the text. Problems have been identified at the end of sections to be solved specifically with Maple, and there are computer laboratory activities, which are more difficult problems designed for Maple. In addition, MATLAB and Excel have been included in the solution of problems in several of the chapters. There is a solutions manual available for those who select the text for their course. This text can be used in two semesters of engineering mathematics. The many helpful features make the text relatively easy to use in the classroom.

The complete text has been divided into two volumes: Volume I (Ch. 1-13) & Volume II (Ch. 14-25). In addition To The

review material and some basic topics as discussed in the opening chapter, The main text in Volume I covers topics on infinite series, differential and integral calculus, matrices, vector calculus, ordinary differential equations, special functions and Laplace transforms. The Volume II, which is in sequel to Volume I, covers topics on complex analysis, Fourier analysis, partial differential equations, statistics, numerical methods and linear programming. The self-contained text has numerous distinguishing features over the already existing books on the same topic. The chapters have been planned to create interest among the readers to study and apply the mathematical tools. The subject has been presented in a very lucid and precise manner with a wide variety of examples and exercises, which would eventually help the reader for hassle-free study. The book can be used as a text for Engineering Mathematics Course at various levels. New in this Edition * Numerical Methods in General * Numerical Methods for Differential Equations * Linear Programming

A concise, systematic treatment of probabilistic calculations of the sort used in electronic communication, radar, and automatic control. Appropriate as a text in stochastic processes, statistical communication methods, or automatic control. First section discusses random variables. Second section deals with random processes, and response of linear systems to random processes. Each theoretical topic is followed by a description of the associated computational procedures. Chapters contain problems, with solutions.

Known for its accessible, precise approach, Epp's DISCRETE MATHEMATICS WITH APPLICATIONS, 5th Edition, introduces discrete mathematics with clarity and precision. Coverage emphasizes the major themes of discrete mathematics as well as the reasoning that underlies mathematical thought. Students learn to think abstractly as they study the ideas of logic and proof. While learning about logic circuits and computer addition, algorithm analysis, recursive thinking, computability, automata, cryptography and combinatorics, students discover that ideas of discrete mathematics underlie and are essential to today's science and technology. The author's emphasis on reasoning provides a foundation for computer science and upper-level mathematics courses. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

Since its introduction in 1984, MATLAB's ever-growing popularity and functionality have secured its position as an industry-standard software package. The user-friendly, interactive environment of MATLAB 6.x, which includes a high-level programming language, versatile graphics capabilities, and abundance of intrinsic functions, helps users focus on their applications rather than on programming errors. MATLAB has now leapt far ahead of FORTRAN as the software of choice for engineering applications.

Number theory is one of the oldest branches of mathematics that is primarily concerned with positive integers. While it has long been studied for its beauty and elegance as a branch of pure mathematics, it has seen a resurgence in recent years with the advent of the digital world for its modern applications in both computer science and cryptography. Number Theory: Step by Step is an undergraduate-level introduction to number theory that assumes no prior knowledge, but works to gradually increase the reader's confidence and ability to tackle more difficult material. The strength of the text is in its large number of examples and the step-by-step explanation of each topic as it is introduced to help aid understanding the abstract mathematics of number theory. It is compiled in such a way that allows self-study, with explicit solutions to all the set of problems freely available online via the companion website. Punctuating the text are short and engaging historical profiles that add context for the topics covered and provide a dynamic background for the subject matter.

Beginning with linear algebra and later expanding into calculus of variations, Advanced Engineering Mathematics provides accessible and comprehensive mathematical preparation for advanced undergraduate and beginning graduate students taking engineering courses. This book offers a review of standard mathematics coursework while effectively integrating science and engineering throughout the text. It explores the use of engineering applications, carefully explains links to engineering practice, and introduces the mathematical tools required for understanding and utilizing software packages. Provides comprehensive coverage of mathematics used by engineering students Combines stimulating examples with formal exposition and provides context for the mathematics presented Contains a wide variety of applications and homework problems Includes over 300 figures, more than 40 tables, and over 1500 equations Introduces useful Mathematica™ and MATLAB® procedures Presents faculty and student ancillaries, including an online student solutions manual, full solutions manual for instructors, and full-color figure sides for classroom presentations Advanced Engineering Mathematics covers ordinary and partial differential equations, matrix/linear algebra, Fourier series and transforms, and numerical methods. Examples include the singular value decomposition for matrices, least squares solutions, difference equations, the z-transform, Rayleigh methods for matrices and boundary value problems, the Galerkin method, numerical stability, splines, numerical linear algebra, curvilinear coordinates, calculus of variations, Liapunov functions, controllability, and conformal mapping. This text also serves as a good reference book for students seeking additional information. It incorporates Short Takes sections, describing more advanced topics to readers, and Learn More about It sections with direct references for readers wanting more in-depth information.

This text teaches maths in a step-by-step fashion – ideal for students on first-year engineering and pre-degree courses. - Hundreds of examples and exercises, the majority set in an applied engineering context so that you immediately see the purpose of what you are learning - Introductory chapter revises indices, fractions, decimals, percentages and ratios - Fully worked solutions to every problem on the companion website at www.palgrave.com/engineering/singh plus searchable glossary, e-index, extra exercises, extra content and more!

Introductory Mathematics for Engineering Applications, 2nd Edition, provides first-year engineering students with a practical, applications-based approach to the subject. This comprehensive textbook covers pre-calculus, trigonometry, calculus, and differential equations in the context of various discipline-specific engineering applications. The text offers

numerous worked examples and problems representing a wide range of real-world uses, from determining hydrostatic pressure on a retaining wall to measuring current, voltage, and energy stored in an electrical capacitor. Rather than focusing on derivations and theory, clear and accessible chapters deliver the hands-on mathematical knowledge necessary to solve the engineering problems students will encounter in their careers. The textbook is designed for courses that complement traditional math prerequisites for introductory engineering courses — enabling students to advance in their engineering curriculum without first completing calculus requirements. Now available in enhanced ePub format, this fully updated second edition helps students apply mathematics to engineering scenarios involving physics, statics, dynamics, strength of materials, electric circuits, and more.

Linear algebra is a fundamental area of mathematics, and is arguably the most powerful mathematical tool ever developed. It is a core topic of study within fields as diverse as: business, economics, engineering, physics, computer science, ecology, sociology, demography and genetics. For an example of linear algebra at work, one needs to look no further than the Google search engine, which relies upon linear algebra to rank the results of a search with respect to relevance. The strength of the text is in the large number of examples and the step-by-step explanation of each topic as it is introduced. It is compiled in a way that allows distance learning, with explicit solutions to set problems freely available online. The miscellaneous exercises at the end of each chapter comprise questions from past exam papers from various universities, helping to reinforce the reader's confidence. Also included, generally at the beginning of sections, are short historical biographies of the leading players in the field of linear algebra to provide context for the topics covered. The dynamic and engaging style of the book includes frequent question and answer sections to test the reader's understanding of the methods introduced, rather than requiring rote learning. When first encountered, the subject can appear abstract and students will sometimes struggle to see its relevance; to counter this, the book also contains interviews with key people who use linear algebra in practice, in both professional and academic life. It will appeal to undergraduate students in mathematics, the physical sciences and engineering.

Thoroughly Updated, Zill'S Advanced Engineering Mathematics, Third Edition Is A Compendium Of Many Mathematical Topics For Students Planning A Career In Engineering Or The Sciences. A Key Strength Of This Text Is Zill'S Emphasis On Differential Equations As Mathematical Models, Discussing The Constructs And Pitfalls Of Each. The Third Edition Is Comprehensive, Yet Flexible, To Meet The Unique Needs Of Various Course Offerings Ranging From Ordinary Differential Equations To Vector Calculus. Numerous New Projects Contributed By Esteemed Mathematicians Have Been Added. Key Features O The Entire Text Has Been Modernized To Prepare Engineers And Scientists With The Mathematical Skills Required To Meet Current Technological Challenges. O The New Larger Trim Size And 2-Color Design Make The Text A Pleasure To Read And Learn From. O Numerous NEW Engineering And Science Projects Contributed By Top Mathematicians Have Been Added, And Are Tied To Key Mathematical Topics In The Text. O Divided Into Five Major Parts, The Text'S Flexibility Allows Instructors To Customize The Text To Fit Their Needs. The First Eight Chapters Are Ideal For A Complete Short Course In Ordinary Differential Equations. O The Gram-Schmidt Orthogonalization Process Has Been Added In Chapter 7 And Is Used In Subsequent Chapters. O All Figures Now Have Explanatory Captions. Supplements O Complete Instructor'S Solutions: Includes All Solutions To The Exercises Found In The Text. Powerpoint Lecture Slides And Additional Instructor'S Resources Are Available Online. O Student Solutions To Accompany Advanced Engineering Mathematics, Third Edition: This Student Supplement Contains The Answers To Every Third Problem In The Textbook, Allowing Students To Assess Their Progress And Review Key Ideas And Concepts Discussed Throughout The Text. ISBN: 0-7637-4095-0

Advanced Engineering Mathematics: Applications Guide is a text that bridges the gap between formal and abstract mathematics, and applied engineering in a meaningful way to aid and motivate engineering students in learning how advanced mathematics is of practical importance in engineering. The strength of this guide lies in modeling applied engineering problems. First-order and second-order ordinary differential equations (ODEs) are approached in a classical sense so that students understand the key parameters and their effect on system behavior. The book is intended for undergraduates with a good working knowledge of calculus and linear algebra who are ready to use Computer Algebra Systems (CAS) to find solutions expeditiously. This guide can be used as a stand-alone for a course in Applied Engineering Mathematics, as well as a complement to Kreyszig's Advanced Engineering Mathematics or any other standard text.

This market leading text is known for its comprehensive coverage, careful and correct mathematics, outstanding exercises and self contained subject matter parts for maximum flexibility. Thoroughly updated and streamlined to reflect new developments in the field, the ninth edition of this bestselling text features modern engineering applications and the uses of technology. Kreyszig introduces engineers and computer scientists to advanced math topics as they relate to practical problems. The material is arranged into seven independent parts: ODE; Linear Algebra, Vector Calculus; Fourier Analysis and Partial Differential Equations; Complex Analysis; Numerical methods; Optimization, graphs; and Probability and Statistics.

A groundbreaking and comprehensive reference that's been a bestseller since 1970, this new edition provides a broad mathematical survey and covers a full range of topics from the very basic to the advanced. For the first time, a personal tutor CD-ROM is included.

Based on and enriched by the long-term teaching experience of the authors, this volume covers the major themes of mathematics in engineering and technical specialties. The book addresses the elements of linear algebra and analytic geometry, differential calculus of a function of one variable, and elements of higher algebra. On each theme the authors first present short theoretical overviews and then go on to give problems to be solved. The authors provide the solutions to some typical, relatively difficult problems and guidelines for solving them. The authors consider the development of the self-dependent thinking ability of students in the construction of problems and indicate which problems are relatively difficult. The book is geared so that some of the problems presented can be solved in class, and others are meant to be solved independently. An extensive, explanatory solution of at least one typical problem is included, with emphasis on applications, formulas, and rules. This volume is primarily addressed to advanced students of engineering and technical specialties as well as to engineers/technicians and instructors of mathematics. Key features: Presents the theoretical background necessary for solving problems, including definitions, rules, formulas, and theorems on the particular theme Provides an extended solution of at least one problem on every theme and guidelines for solving some difficult problems Selects problems for independent study as well as those for classroom time, taking into account the similarity of both sets of problems Differentiates relatively difficult problems from others for those who want to study mathematics more deeply Provides answers to the problems within the text rather than at the back of the book, enabling more direct verification of problem solutions Presents a selection of problems and solutions that are very interesting not only for the students but also for professor-teacher staff

This book provides a complete course for first-year engineering mathematics. Whichever field of engineering you are studying, you will be most likely to require knowledge of the mathematics presented in this textbook. Taking a thorough approach, the authors put the concepts into an engineering context, so you can understand the relevance of mathematical techniques presented and gain a fuller appreciation of how to draw upon them throughout your studies.

Appropriate for one- or two-semester Advanced Engineering Mathematics courses in departments of Mathematics and Engineering. This clear, pedagogically rich book develops a strong understanding of the mathematical principles and practices that today's engineers and scientists need to know. Equally effective as either a textbook or reference manual, it approaches mathematical concepts from a practical-use

perspective making physical applications more vivid and substantial. Its comprehensive instructional framework supports a conversational, down-to-earth narrative style offering easy accessibility and frequent opportunities for application and reinforcement.

Accompanying CD-ROM contains ... "a chapter on engineering statistics and probability / by N. Bali, M. Goyal, and C. Watkins."--CD-ROM label.

John Bird's approach, based on numerous worked examples and interactive problems, is ideal for students from a wide range of academic backgrounds, and can be worked through at the student's own pace. Basic mathematical theories are explained in a straightforward manner, being supported by practical engineering examples and applications in order to ensure that readers can relate theory to practice. The extensive and thorough topic coverage makes this an ideal text for a range of university degree modules, foundation degrees, and HNC/D units. Now in its sixth edition, Higher Engineering Mathematics is an established textbook that has helped many thousands of students to gain exam success. It has been updated to maximise the book's suitability for first year engineering degree students and those following foundation degrees. This book also caters specifically for the engineering mathematics units of the Higher National Engineering schemes from Edexcel. As such it includes the core unit, Analytical Methods for Engineers, and two specialist units, Further Analytical Methods for Engineers and Engineering Mathematics, both of which are common to the electrical/electronic engineering and mechanical engineering pathways. For ease of reference a mapping grid is included that shows precisely which topics are required for the learning outcomes of each unit. The book is supported by a suite of free web downloads: • Introductory-level algebra: To enable students to revise the basic algebra needed for engineering courses – available at <http://books.elsevier.com/companions/XXXXXXXXXX> • Instructor's Manual: Featuring full worked solutions and mark schemes for all of the assignments in the book and the remedial algebra assignment – available at <http://www.textbooks.elsevier.com> (for lecturers only) • Extensive Solutions Manual: 640 pages featuring worked solutions for 1,000 of the further problems and exercises in the book – available on <http://www.textbooks.elsevier.com> (for lecturers only)

Engineers require a solid knowledge of the relationship between engineering applications and underlying mathematical theory. However, most books do not present sufficient theory, or they do not fully explain its importance and relevance in understanding those applications. Advanced Engineering Mathematics with Modeling Applications employs a balanced approach to address this informational void, providing a solid comprehension of mathematical theory that will enhance understanding of applications – and vice versa. With a focus on modeling, this book illustrates why mathematical methods work, when they apply, and what their limitations are. Designed specifically for use in graduate-level courses, this book: Emphasizes mathematical modeling, dimensional analysis, scaling, and their application to macroscale and nanoscale problems Explores eigenvalue problems for discrete and continuous systems and many applications Develops and applies approximate methods, such as Rayleigh-Ritz and finite element methods Presents applications that use contemporary research in areas such as nanotechnology Apply the Same Theory to Vastly Different Physical Problems Presenting mathematical theory at an understandable level, this text explores topics from real and functional analysis, such as vector spaces, inner products, norms, and linear operators, to formulate mathematical models of engineering problems for both discrete and continuous systems. The author presents theorems and proofs, but without the full detail found in mathematical books, so that development of the theory does not obscure its application to engineering problems. He applies principles and theorems of linear algebra to derive solutions, including proofs of theorems when they are instructive. Tying mathematical theory to applications, this book provides engineering students with a strong foundation in mathematical terminology and methods.

Advanced Engineering Mathematics provides comprehensive and contemporary coverage of key mathematical ideas, techniques, and their widespread applications, for students majoring in engineering, computer science, mathematics and physics. Using a wide range of examples throughout the book, Jeffrey illustrates how to construct simple mathematical models, how to apply mathematical reasoning to select a particular solution from a range of possible alternatives, and how to determine which solution has physical significance. Jeffrey includes material that is not found in works of a similar nature, such as the use of the matrix exponential when solving systems of ordinary differential equations. The text provides many detailed, worked examples following the introduction of each new idea, and large problem sets provide both routine practice, and, in many cases, greater challenge and insight for students. Most chapters end with a set of computer projects that require the use of any CAS (such as Maple or Mathematica) that reinforce ideas and provide insight into more advanced problems. Comprehensive coverage of frequently used integrals, functions and fundamental mathematical results Contents selected and organized to suit the needs of students, scientists, and engineers Contains tables of Laplace and Fourier transform pairs New section on numerical approximation New section on the z-transform Easy reference system

Market_Desc: • Engineers• Students• Professors in Engineering Math Special Features: • New ideas are emphasized, such as stability, error estimation, and structural problems of algorithms• Focuses on the basic principles, methods and results in Modeling, solving and interpreting problems• More emphasis on applications and qualitative methods About The Book: The book introduces engineers, computer scientists, and physicists to advanced math topics as they relate to practical problems. The material is arranged into seven independent parts: ODE; Linear Algebra, Vector calculus; Fourier Analysis and Partial Differential Equations; Complex Analysis; Numerical methods; Optimization, graphs; Probability and Statistics.

Advanced Engineering Mathematics with Mathematica® presents advanced analytical solution methods that are used to solve boundary-value problems in engineering and integrates these methods with Mathematica® procedures. It emphasizes the Sturm–Liouville system and the generation and application of orthogonal functions, which are used by the separation of variables method to solve partial differential equations. It introduces the relevant aspects of complex

variables, matrices and determinants, Fourier series and transforms, solution techniques for ordinary differential equations, the Laplace transform, and procedures to make ordinary and partial differential equations used in engineering non-dimensional. To show the diverse applications of the material, numerous and widely varied solved boundary value problems are presented.

O'Neil's ADVANCED ENGINEERING MATHEMATICS, 8E makes rigorous mathematical topics accessible to today's learners by emphasizing visuals, numerous examples, and interesting mathematical models. New Math in Context broadens the engineering connections by demonstrating how mathematical concepts are applied to current engineering problems. The reader has the flexibility to select from a variety of topics to study from additional posted web modules. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

This is the student Solutions Manual to accompany Advanced Engineering Mathematics, Volume 2, Tenth Edition. This market-leading text is known for its comprehensive coverage, careful and correct mathematics, outstanding exercises, and self contained subject matter parts for maximum flexibility. The new edition continues with the tradition of providing instructors and students with a comprehensive and up-to-date resource for teaching and learning engineering mathematics, that is, applied mathematics for engineers and physicists, mathematicians and computer scientists, as well as members of other disciplines.

The aim of this book is to help the readers understand the concepts, techniques, terminologies, and equations appearing in the existing books on engineering mathematics using MATLAB. Using MATLAB for computation would be otherwise time consuming, tedious and error-prone. The readers are recommended to have some basic knowledge of MATLAB. Differential equations, especially nonlinear, present the most effective way for describing complex physical processes. Methods for constructing exact solutions of differential equations play an important role in applied mathematics and mechanics. This book aims to provide scientists, engineers and students with an easy-to-follow, but comprehensive, description of the methods for constructing exact solutions of differential equations.

The Akst/Bragg series' success is built around clear and concise writing, a side-by-side "teach by example" approach, and integrated applications throughout that help students achieve a conceptual understanding. The user-friendly design offers a distinctive side-by-side format that pairs examples and their solutions with corresponding practice exercises. Students understand from the very beginning that doing math is an essential part of learning it. Motivational, real-world applications demonstrate how integral mathematical understanding is to a variety of disciplines, careers, and everyday situations.

This book is a compendium of fundamental mathematical concepts, methods, models, and their wide range of applications in diverse fields of engineering. It comprises essentially a comprehensive and contemporary coverage of those areas of mathematics which provide foundation to electronic, electrical, communication, petroleum, chemical, civil, mechanical, biomedical, software, and financial engineering. It gives a fairly extensive treatment of some of the recent developments in mathematics which have found very significant applications to engineering problems.

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