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Discrete Element Analysis Methods of Generic Differential Quadratures-Chang-New Chen 2008-09-12 Following the advance in computer technology, the numerical technique has made signi?cant progress in the past decades. Among the major techniques available for numerically analyzing continuum mechanics problems, ?nite d- ference method is most early developed. It is di?cult to deal with cont- uum mechanics problems showing complex curvilinear geometries by using this method. The other method that can consistently discretize continuum mechanics problems showing arbitrarily complex geometries is ?nite element method. In addition, boundary element method is also a useful numerical method. In the past decade, the di?erential quadrature and generic di?erential quadraturesbaseddiscreteelementanalysismethodshavebeendevelopedand usedto solve various continuum mechanics problems. These methods have the same advantage as ?nite element method of consistently discretizing cont- uum mechanics problems having arbitrarily complex geometries. This book includes my research results obtained in developing the related novel discrete element analysis methods using both of the extended di?erential quadrature based spacial and temporal elements. It is attempted to introduce the dev- oped numerical techniques as applied to the solution of various continuum mechanics problems, systematically.

Discrete Element Analysis by Combined Method Formulation-Marlin Don / Minich 1967

Computational Modeling of Masonry Structures Using the Discrete Element Method-Sarhosis, Vasilis 2016-06-09 The Discrete Element Method (DEM) has emerged as a solution to predicting load capacities of masonry structures. As one of many numerical methods and computational solutions being applied to evaluate masonry structures, further research on DEM tools and methodologies is essential for further advancement. Computational Modeling of Masonry Structures Using the Discrete Element Method explores the latest digital solutions for the analysis and modeling of brick, stone, concrete, granite, limestone, and glass block structures. Focusing on critical research on mathematical and computational methods for masonry analysis, this publication is a pivotal reference source for scholars, engineers, consultants, and graduate-level engineering students.

Discrete Element Methods-Benjamin K. Cook 2002 Proceedings of the Third International Conference on Discrete Element Methods, held in Santa Fe, New Mexico on September 23-25, 2002. This Geotechnical Special Publication contains 72 technical papers on discrete element methods (DEM), a suite of numerical techniques developed to model granular materials, rock, and other discontinua at the grain scale. Topics include: DEM formulation and implementation approaches, coupled methods, experimental validation, and techniques, including three-dimensional particle representations, efficient contact detection algorithms, particle packing schemes, and code design. Coupled methods include approaches to linking solid continuum and fluid models with DEM to simulate multiscale and multiphase phenomena. Applications include fundamental investigations of granular mechanics; micromechanical studies of powder, soil, and rock behavior; and large-scale modeling of geotechnical, material processing, mining, and petroleum engineering problems.

Coupled Finite-discrete Element Analysis of Soil-pipe Interaction-Masood Meidani 2019 "Buried pipes are safe and economical method of transporting natural resources. Failure of these infrastructures poses significant damage to the environment and people safety. Permanent ground deformation is one of the major causes of buried pipe failure. It was reported that axial force on pipes buried in dense granular material obtained using the current guidelines can be significantly smaller than the measured values. Standard finite element methods are known to be efficient in studying soil-structure interaction problems, however, modeling soil-structure interaction involving granular material and large deformation is challenging, particularly at the particle scale level. On the other hand, the discrete element method has proven its capability in capturing the response of granular material at the microscopic scale. However, the method has some limitation in modeling flexible structural elements. Coupling the discrete and finite elements methods is a promising approach that takes advantage of the two methods. In this thesis, the response of buried pipes subject to axial and lateral ground movements are evaluated using three-dimensional discrete and coupled discrete-finite element methods. The research results have been published in refereed journals and presented in seven chapters that comprise this manuscript-based thesis. The behavior of rigid pipe buried in dense sand under axial ground movement is first evaluated using discrete element method. The input parameters of the model are obtained using a precise calibration procedure and numerical results are validated using experimental data. Results indicated that, for the rigid pipes buried in dense sand, current equations may not properly consider the dilative behavior of the soil and underestimate the soil axial resistance. The numerical approach has proven to be efficient in modeling pipelines subjected to relative soil movement. The created model is then used to conduct a comprehensive parametric study to develop a new expression that estimates the earth pressure coefficient and the soil axial resistance acting on the rigid pipe. A three-dimensional coupled finite-discrete element framework has been developed and used to investigate the response of a (medium density polyethylene) MDPE pipe under axial and lateral relative ground movements. The pipe is modeled using finite elements while the surrounding soil is modeled using discrete elements. Interface elements are used to transfer forces between these two domains. The response of the soil at microscale level was analyzed and the deformations and strains developing in the MDPE pipe were investigated. Results showed that caution must be considered when using current methods in the analysis of MDPE pipes. Conclusions and recommendations have been made on the pipe-soil interactions under soil movement." --

Matrix Discrete Element Analysis of Geological and Geotechnical Engineering-Chun Liu 2021-01-23 This book introduces the basic structure, modeling methods, numerical calculation processes, post-processing, and system functions of MatDEM, which applies the basic principles and algorithm of the discrete element method. The discrete element method can effectively simulate the discontinuity, inhomogeneity, and large deformation damage of rock and soil. It is widely used in both research and industry. Based on the innovative matrix discrete element computing method, the author developed the high-performance discrete element software MatDEM from scratch, which can handle millions of elements in discrete element numerical simulations. This book also presents several examples of applications in geological and geotechnical engineering, including basic geotechnical engineering problems, discrete element tests, three dimensional landslides, and dynamic and multi-field coupling functions. Teaching videos and the relevant software can be accessed on the MATDEM website (http://matdem.com). The book serves as a useful reference for research and engineering staff, undergraduates, and postgraduates who work in the fields of geology, geotechnical, water conservancy, civil engineering, mining, and physics.

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Analysis and Improvement of the Time Driven Discrete Element Method-Harald Kruggel-Emden 2008

Particle-Based Methods-Eugenio Oñate 2011-02-17 The book contains 11 chapters written by relevant scientists in the field of particle-based methods and their applications in engineering and applied sciences. The chapters cover most particle-based techniques used in practice including the discrete element method, the smooth particle hydrodynamic method and the particle finite element method. The book will be of interest to researchers and engineers interested in the fundamentals of particle-based methods and their applications.

Matrix Discrete Element Analysis of Geological and Geotechnical Engineering-Chun Liu 2021-02-21 This book introduces the basic structure, modeling methods, numerical calculation processes, post-processing, and system functions of MatDEM, which applies the basic principles and algorithm of the discrete element method. The discrete element method can effectively simulate the discontinuity, inhomogeneity, and large deformation damage of rock and soil. It is widely used in both research and industry. Based on the innovative matrix discrete element computing method, the author developed the high-performance discrete element software MatDEM from scratch, which can handle millions of elements in discrete element numerical simulations. This book also presents several examples of applications in geological and geotechnical engineering, including basic geotechnical engineering problems, discrete element tests, three dimensional landslides, and dynamic and multi-field coupling functions. Teaching videos and the relevant software can be accessed on the MATDEM website (http://matdem.com). The book serves as a useful reference for research and engineering staff, undergraduates, and postgraduates who work in the fields of geology, geotechnical, water conservancy, civil engineering, mining, and physics.

A Discrete Element Method for the Analysis of a Tapered Fuselage-Joseph Robert Lloyd 1966

Proceedings of the 7th International Conference on Discrete Element Methods-Xikui Li 2016-12-01 This book presents the latest advances in Discrete Element Methods (DEM) and technology. It is the proceeding of 7th International Conference on DEM which was held at Dalian University of Technology on August 1 - 4, 2016. The subject of this book are the DEM and related computational techniques such as DDA, FEM/DEM, molecular dynamics, SPH, Meshless methods, etc., which are the main computational methods for modeling discontinua. In comparison to continua which have been already studied for a long time, the research of discontinua is relatively new, but increases dramatically in recent years and has already become an important field. This book will benefit researchers and scientists from the academic fields of physics, engineering and applied mathematics, as well as from industry and national laboratories who are interested in the DEM.

Engineering Applications of Discrete Element Method-Xuewen Wang 2020-09-10 This book introduces the engineering application of the discrete element method (DEM), especially the simulation analysis of the typical equipment (scraper conveyor, coal silos, subsoiler) in the coal and agricultural machinery. In this book, the DEM is applied to build rigid and loose coupling model, and the kinematic effect of the bulk materials, the mechanical effect of the interaction between the bulk materials, and the mechanical equipment in the operation process of the relevant equipment are studied. On this basis, the optimization design strategy of the relevant structure is proposed. This book effectively promotes the application of DEM in engineering, analyzes the operation state, failure mechanism, and operation effect of related equipment in operation, and provides theoretical basis for the optimal design of equipment. The book is intended for undergraduate and graduate students who are interested in mechanical engineering, researchers investigating coal and agricultural machinery, and engineers working on designing related equipments.

Fundamentals of Discrete Element Methods for Rock Engineering: Theory and Applications-Lanru Jing 2007-07-18 This book presents some fundamental concepts behind the basic theories and tools of discrete element methods (DEM), its historical development, and its wide scope of applications in geology, geophysics and rock engineering. Unlike almost all books available on the general subject of DEM, this book includes coverage of both explicit and implicit DEM approaches, namely the Distinct Element Methods and Discontinuous Deformation Analysis (DDA) for both rigid and deformable blocks and particle systems, and also the Discrete Fracture Network (DFN) approach for fluid flow and solute transport simulations. The latter is actually also a discrete approach of importance for rock mechanics and rock engineering. In addition, brief introductions to some alternative approaches are also provided, such as percolation theory and Cosserat micromechanics equivalence to particle systems, which often appear hand-in-hand with the DEM in the literature. Fundamentals of the particle mechanics approach using DEM for granular media is also presented. · Presents the fundamental concepts of the discrete models for fractured rocks, including constitutive models of rock fractures and rock masses for stress, deformation and fluid flow · Provides a comprehensive presentation on discrete element methods, including distinct elements, discontinuous deformation analysis, discrete fracture networks, particle mechanics and Cosserat representation of granular media · Features constitutive models of rock fractures and fracture system characterization methods detaiing their significant impacts on the performance and uncertainty of the DEM models

Extended Discrete Element Method for Subject Specific Modelling and Analysis of the Ankle Joint Contact Mechanics-Ivan Benemerito 2018

Discrete Element Method for Modeling Solid and Particulate Materials-Federico A. Tavarez 2005

Particulate Discrete Element Modelling-Catherine O'Sullivan 2011-04-06 Particulate discrete element analysis is becoming increasingly popular for research in geomechanics as well as geology, chemical engineering, powder technology, petroleum engineering and in studying the physics of granular materials. With increased computing power, practising engineers are also becoming more interested in using this technology for analysis in industrial applications. This is the first single work on Discrete Element Modelling (DEM) providing the information to get started with this powerful numerical modelling approach. Written by an independent author with experience both in developing DEM codes and using commercial codes, this book provides the basic details of the numerical method and the approaches used to interpret the results of DEM simulations. Providing a basic overview of the numerical method, Particulate Discrete Element Modelling discusses issues related to time integration and numerical stability, particle types, contact modelling and boundary conditions. It summarizes approaches to interpret DEM data so that users can maximize their insight into the material response using DEM. The aim of this book is to provide both users and prospective users of DEM with a concise reference book that includes tips to optimize their usage. Particulate Discrete Element Modelling is suitable both for first time DEM analysts as well as more experienced users. It will be of use to professionals, researchers and higher level students, as it presents a theoretical overview of DEM as well as practical guidance on running DEM simulations and interpreting DEM simulation data.

Discrete-element Analysis of Core-stiffened Shells of Revolution-Frank Chi-Pong Yin 1967 A method is proposed for achieving complete displacement compatibility between a conical shell of revolution and an enclosed core stiffener when using the discrete-element method of analysis. The equations and matrices (stiffness, mass, and nodal loads) necessary to carry out either static or dynamic analyses of the core-stiffened shell of revolution are derived, and application of the method in the static case is shown by two example problems.

Modeling and Simulation of Functionalized Materials for Additive Manufacturing and 3D Printing: Continuous and Discrete Media-Tarek I. Zohdi 2017-12-22 Within the last decade, several industrialized countries have stressed the importance of advanced manufacturing to their economies. Many of these plans have highlighted the development of additive manufacturing techniques, such as 3D printing which, as of 2018, are still in their infancy. The objective is to develop superior products, produced at lower overall operational costs. For these goals to be realized, a deep understanding of the essential ingredients comprising the materials involved in additive manufacturing is needed. The combination of rigorous material modeling theories, coupled with the dramatic increase of computational power can potentially play a significant role in the analysis, control, and design of many emerging additive manufacturing processes. Specialized materials and the precise design of their properties are key factors in the processes. Specifically, particle-functionalized materials play a central role in this field, in three main regimes: (1) to enhance overall filament-based material properties, by embedding particles within a binder, which is then passed through a heating element and the deposited onto a surface, (2) to “functionalize” inks by adding particles to freely flowing solvents forming a mixture, which is then deposited onto a surface and (3) to directly deposit particles, as dry powders, onto surfaces and then to heat them with a laser, e-beam or other external source, in order to fuse them into place. The goal of these processes is primarily to build surface structures which are extremely difficult to construct using classical manufacturing methods. The objective of this monograph is introduce the readers to basic techniques which can allow them to rapidly develop and analyze particulate-based materials needed in such additive manufacturing processes. This monograph is broken into two main parts: “Continuum Method” (CM) approaches and “Discrete Element Method” (DEM) approaches. The materials associated with methods (1) and (2) are closely related types of continua (particles embedded in a continuous binder) and are treated using continuum approaches. The materials in method (3), which are of a discrete particulate character, are analyzed using discrete element methods.

The Combined Finite-Discrete Element Method-Antonio A. Munjiza 2004-04-21 The combined finite discrete element method is a relatively new computational tool aimed at problems involving static and / or dynamic behaviour of systems involving a large number of solid deformable bodies. Such problems include fragmentation using explosives (e.g rock blasting), impacts, demolition (collapsing buildings), blast loads, digging and loading processes, and powder technology. The combined finite-discrete element method - a natural extension of both discrete and finite element methods - allows researchers to model problems involving the deformability of either one solid body, a large number of bodies, or a solid body which fragments (e.g. in rock blasting applications a more or less intact rock mass is transformed into a pile of solid rock fragments of different sizes, which interact with each other). The topic is gaining in importance, and is at the forefront of some of the current efforts in computational modeling of the failure of solids. * Accompanying source codes plus input and output files available on the Internet * Important applications such as mining engineering, rock blasting and petroleum engineering * Includes practical examples of applications areas Essential reading for postgraduates, researchers and software engineers working in mechanical engineering.

A discrete-element method of pile-driving analysis-Patrick Lee Meyer 1976

Finite Deflection, Discrete Element Analysis of Shells-Fred K. Bogner 1968 A discrete element analysis method for predicting the nonlinear response of thin elastic shells is presented. The displacement patterns for a shell element, the edges of which must be parallel to orthogonal curvilinear coordinates, are expressed in terms of products of one-dimensional Hermite interpolation polynomials and undetermined nodal displacement parameters. Geometric admissibility of the displacement state of an assemblage of these discrete elements is conveniently satisfied. Special treatment is given to the particular cases of flat rectangular plate and circular cylindrical shell discrete elements. The use of a potential energy principle permits the incorporation of geometric nonlinearity, thus providing the capability for predicting finite displacements and post-buckling behavior. Numerical solutions are obtained by direct minimization of the total discretized potential energy. Several numerical examples, both linear and nonlinear, which indicate the effectiveness of the analysis are considered. The applicability of this discrete element analysis method to predicting the elastic post-buckling behavior of integrally stiffened shells is provided by the assumed element displacement patterns. (Author).

3D Discrete Element Workbench for Highly Dynamic Thermo-mechanical Analysis-Jean-Luc Charles 2015-10-12 Complex behavior models (plasticity, cracks, visco elascticity) face some theoretical difficulties for the determination of the behavior law at the continuous scale. When homogenization fails to give the right behavior law, a solution is to simulate the material at a meso scale in order to simulate directly a set of discrete properties that are responsible of the macroscopic behavior. The discrete element model has been developed for granular material. The proposed set shows how this method is capable to solve the problem of complex behavior that are linked to discrete meso scale effects. The first book solves the local problem, the second one presents a coupling approach to link the structural effects to the local ones, this third book presents the software workbench that includes all the theoretical developments.

A Discrete Element Method for the Analysis of Deep Beams-Bo L. O. Edlund 1965

Discrete Element Analysis of Indirect Tensile Test Based on Image Processing with Annular Segmentation and Bimodal Threshold-Xueying Liu 2020 The discrete element method (DEM) has recently been widely used to analyze the micromechanics behavior of asphalt mixtures. The objective of this study is to present a more accurate image-processing technique to perform an indirect tensile test of asphalt mixture. Cross-sectional images of the specimen were obtained by an X-ray computed tomography (CT) technique. These CT images were processed by annular segmentation combined with bimodal threshold. The image information was transformed to coordinate information by the user-defined program in Matrix Laboratory (MATLAB). Then, a two-dimensional discrete element model of the indirect tensile test specimen was reconstructed. The indirect tensile test was simulated by the DEM and verified in the laboratory. It was found that this image-processing technology could separate connected or overlapping aggregates and better avoid defects among the aggregates. During the simulation test, the distributed internal forces were gradually concentrated along the loading axis. Four-stage crack initially appeared directly under the loading area and quickly developed along the interface between the aggregate and mortar, mainly along the loading axis. In view of the consistency of the load-displacement curves and crack distribution characteristics in both the simulation and laboratory tests, this numerical method is able to simulate the indirect tensile test.

Discrete Element Method for Slope Stability Analysis-Adrian Rodriguez-Marek 1996

Laboratory Investigation and Discrete Element Analysis in Open-graded Friction Course and Railway Crosstie-ballast Interaction-Weimin Song 2017 Granular materials, such as ballast and aggregate, are widely used nowadays in civil and transportation engineering. Discrete element method has been extensively used to simulate the behavior of granular materials. In this study, properties of granular materials used in pavement and railway were investigated by laboratory tests and discrete element modeling. Firstly, the bonding performance between pavement layers was evaluated. Open-graded friction course pavement and traditional dense asphalt mixture pavement were both explored. Two dense asphalt mixtures (D, BM) and one open-graded friction course (OGFC) mixture were selected for the comparison. The laboratory test results show that, for traditional dense samples, the interlock effect between layers played an important role in pavement layer bonding. For specimens composed of OGFC and a dense mixture (D or BM), OGFCBM showed a better shear performance than OGFC-D, due to the double effects of a larger interface contact area and a larger interface roughness than OGFC-D. The DEM modeling was focused on the interlock effect between pavement layers by conducting the direct shear box test. Results from DEM modeling show that D-BM gave a higher shear strength, which agreed with the laboratory test. Secondly, laboratory tests were conducted to investigate the shear fatigue performance between OGFC and underlying layer. Results indicate that contact area between OGFC and underlying layer play the critically important role. The larger the contact area, the better the shear fatigue performance. Thirdly, a full scale laboratory test was conducted to investigate the pressure distributions under a single steel or timber crosstie. It is found that pressure distribution was different for steel and timber crossties. Cyclic loading could change the pressure distribution under both steel and timber crossties, but the effect of cyclic loading was more obvious on steel crosstie than on timber crosstie. Last, one coupled framework between discrete element method (DEM) and finite element method (FEM) was developed to investigate the ballast-tie interaction. The normal contact condition and the stress distribution beneath the steel crosstie and timber crosstie were obtained from the simulation. Stress distribution obtained by DEM-FEM simulation was consistent with the findings from the laboratory test.

The Use of the Discrete Element Method and Smoothed Particle Hydrodynamics for the Dynamic Stability Analysis of Granular Soil-Lu Tong 2020

A Finite Deflection Analysis of Shallow Arches by the Discrete Element Method-D.J. Dawe 1970

Discrete-Element Static Analysis of Bonded, Double-Layer, Branched, Thin Shells of Revolution. Part 1: Analysis and Evaluation-James J. Kotanchik 1968 The methods of discrete-element analysis are applied to the solution of arbitrary shells of revolution having two layers joined by a soft bond; the shell is idealized as a series of frusta with curved meridians, joined at the nodal circles. The displacement assumptions for the soft-bonded two-layer discrete element permit the sliding of the upper and lower layers with respect to each other, but the normal displacement of the upper and lower layers is assumed to be the same. The asymmetric loading problem is handled through a Fourier expansion of the loads and displacements. Numerical results for various shells of revolution for both axisymmetric and asymmetric mechanical and thermal loadings have been obtained to exercise various features and options of the computer program SABOR 5. These results are compared with existing solutions and good correlation is found. The SABOR 5 program can be used for the static analysis of variable-thickness shells of revolution composed of soft-bonded double-layers, single layers, or branched-shell combinations thereof, while accounting for isotropic or general skew orthotropic material properties and for arbitrary (axisymmetric and/or asymmetric) mechanical and/or thermal loads.

A discrete-element method of multiple-loading analysis for two-way bridge floor slabs-John Jesse Panak 1968

A Discrete-element Method of Analysis for Combined Bending and Shear Deformations of a Beam-David F. Tankersley 1969

Application of the Discrete Element Method to the Buckling Analysis of Rectangular Plates Under Arbitrary Membrane Loading-D.J. Dawe 1968

Comprehensive Structural Integrity-I. Milne 2003

A Summary of Discrete-element Methods of Analysis for Pavement Slabs-W. Ronald Hudson 1972

A Discrete-element Method of Multiple-loading Analysis for Two-way Bridge Floor Slabs-John J. Panak 1970

The Finite Element Method for Solid and Structural Mechanics-Olek C Zienkiewicz 2005-08-09 This is the key text and reference for engineers, researchers and senior students dealing with the analysis and modelling of structures – from large civil engineering projects such as dams, to aircraft structures, through to small engineered components. Covering small and large deformation behaviour of solids and structures, it is an essential book for engineers and mathematicians. The new edition is a complete solids and structures text and reference in its own right and forms part of the world-renowned Finite Element Method series by Zienkiewicz and Taylor. New material in this edition includes separate coverage of solid continua and structural theories of rods, plates and shells; extended coverage of plasticity (isotropic and anisotropic); node-to-surface and 'mortar' method treatments; problems involving solids and rigid and pseudo-rigid bodies; and multi-scale modelling. Dedicated coverage of solid and structural mechanics by world-renowned authors, Zienkiewicz and Taylor New material including separate coverage of solid continua and structural theories of rods, plates and shells; extended coverage for small and finite deformation; elastic and inelastic material constitution; contact modelling; problems involving solids, rigid and discrete elements; and multi-scale modelling

The Finite Element Method Set-Olek C Zienkiewicz 2005-11-25 The sixth editions of these seminal books deliver the most up to date and comprehensive reference yet on the finite element method for all engineers and mathematicians. Renowned for their scope, range and authority, the new editions have been significantly developed in terms of both contents and scope. Each book is now complete in its own right and provides self-contained reference; used together they provide a formidable resource covering the theory and the application of the universally used FEM. Written by the leading professors in their fields, the three books cover the basis of the method, its application to solid mechanics and to fluid dynamics. * This is THE classic finite element method set, by two the subject's leading authors * FEM is a constantly developing subject, and any professional or student of engineering involved in understanding the computational modelling of physical systems will inevitably use the techniques in these books * Fully up-to-date; ideal for teaching and reference

On the Accuracy of Nonlinear Analysis of Continua Using the Discrete Element Method-Lily L. Rong 2009

Numerical Differential Equations-Source Wikipedia 2013-09 Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 114. Chapters: Discrete element method, Finite difference, Shooting method, Finite-difference time-domain method, Finite element method, MUSCL scheme, Constraint algorithm, Verlet integration, Runge-Kutta methods, Linear multistep method, Stiff equation, Particle-in-cell, Crank-Nicolson method, Finite element method in structural mechanics, Numerical ordinary differential equations, Direct stiffness method, Flux limiter, Smoothed-particle hydrodynamics, Cea's lemma, Finite difference method, Spectral method, Euler method, Transmission line matrix method, List of Runge-Kutta methods, Discrete Laplace operator, Finite pointset method, Eigenvalues and eigenvectors of the second derivative, Finite volume method, Moving particle semi-implicit method, Discrete Poisson equation, Modal analysis using FEM, Boundary element method, Shock capturing methods, Parallel mesh generation, Galerkin method, Cell lists, Godunov's theorem, Five-point stencil, Vorticity confinement, Symplectic integrator, Split-step method, Perfectly matched layer, Weak formulation, Finite difference coefficient, Finite difference methods for option pricing, Energy drift, Meshfree methods, Geometric integrator, Direct multiple shooting method, Kronecker sum of discrete Laplacians, Image-based meshing, Adaptive stepsize, Numerov's method, Method of lines, Semi-implicit Euler method, Upwind scheme, Trefftz method, Interval boundary element method, Beeman's algorithm, AUSM, Rayleigh-Ritz method, Adaptive mesh refinement, Compact stencil, Godunov's scheme, Partial element equivalent circuit, Alternating direction implicit method, History of numerical solution of differential equations using computers, Variational integrator, Dormand-Prince method, Extended finite element method, Fast multipole method, Midpoint method, Explicit and implicit methods, Immersed...