

Application Of Nanofluid For Heat Transfer Enhancement

Nanofluids are solid-liquid composite material consisting of solid nanoparticles suspended in liquid with enhanced thermal properties. This book introduces basic fluid mechanics, conduction and convection in fluids, along with nanomaterials for nanofluids, property characterization, and outline applications of nanofluids in solar technology, machining and other special applications. Recent experiments on nanofluids have indicated significant increase in thermal conductivity compared with liquids without nanoparticles or larger particles, strong temperature dependence of thermal conductivity, and significant increase in critical heat flux in boiling heat transfer, all of which are covered in the book. Key Features Exclusive title focusing on niche engineering applications of nanofluids Contains high technical content especially in the areas of magnetic nanofluids and dilute oxide based nanofluids Feature examples from research applications such as solar technology and heat pipes Addresses heat transfer and thermodynamic features such as efficiency and work with mathematical rigor Focused in content with precise technical definitions and treatment

Application of Control Volume Based Finite Element Method (CVFEM) for Nanofluid Flow and Heat Transfer discusses this powerful numerical method that uses the advantages of both finite volume and finite element methods for the simulation of multi-physics problems in complex geometries, along with its applications in heat transfer and nanofluid flow. The book applies these methods to solve various applications of nanofluid in heat transfer enhancement. Topics covered include magnetohydrodynamic flow, electrohydrodynamic flow and heat transfer, melting heat transfer, and nanofluid flow in porous media, all of which are demonstrated with case studies. This is an important research reference that will help readers understand the principles and applications of this novel method for the analysis of nanofluid behavior in a range of external forces. Explains governing equations for nanofluid as working fluid Includes several CVFEM codes for use in nanofluid flow analysis Shows how external forces such as electric fields and magnetic field effects nanofluid flow

Nano and Bio Heat Transfer and Fluid Flow focuses on the use of nanoparticles for bio application and bio-fluidics from an engineering perspective. It introduces the mechanisms underlying thermal and fluid interaction of nanoparticles with biological systems. This book will help readers translate theory into real world applications, such as drug delivery and lab-on-a-chip. The content covers how transport at the nano-scale differs from the macro-scale, also discussing what complications can arise in a biologic system at the nano-scale. It is ideal for students and early career researchers, engineers conducting experimental work on relevant applications, or those who develop computer models to investigate/design these systems. Content coverage includes biofluid mechanics, transport phenomena, micro/nano fluid flows, and heat transfer. Discusses nanoparticle applications in drug delivery Covers the engineering fundamentals of bio heat transfer and fluid flow Explains how to simulate, analyze, and evaluate the transportation of heat and mass problems in bio-systems

Hybrid Nanofluids for Convection Heat Transfer discusses how to maximize heat transfer rates with the addition of nanoparticles into conventional heat transfer fluids. The book addresses definitions, preparation techniques, thermophysical properties and heat transfer characteristics with mathematical models, performance-affecting factors, and core applications with implementation challenges of hybrid nanofluids. The work adopts mathematical models and schematic diagrams in review of available experimental methods. It enables readers to create new techniques, resolve existing research problems, and ultimately to implement hybrid nanofluids in convection heat transfer applications. Provides key heat transfer performance and thermophysical characteristics of hybrid nanofluids Reviews parameter selection and property measurement techniques for thermal performance calibration Explores the use of predictive mathematical techniques for experimental properties

Viscosity, heat transfer and pressure loss measurements of several nanofluids, which are suspensions of nanoparticles less than 100 nm size, in base fluids, e.g. ethylene or propylene glycol and water mixture are presented. The nanoparticles considered here are oxides of aluminum, copper and silicon. Effects of thermophysical properties of nanofluids on the Prandtl number and the Mouromtseff number have been analyzed in detail. Authors show that the Prandtl number increases with increasing particle volumetric concentration, which in turn increases the convective heat transfer coefficients of the nanofluids. Experiments on nanofluids in the turbulent regime show the enhancement of convective heat transfer and pressure loss with an increase in nanoparticles volume concentration. The authors prove that application of nanofluids for heating buildings could result in reduction of volume flow rate of heat transfer fluids, heat exchanger size, and the pumping power. Experiment on a diesel electric generator confirms an increase in the thermal efficiency of the heat recovery from the engine radiator for nanofluids compared to the conventional coolant.

Heat transfer enhancement has seen rapid development and widespread use in both conventional and emerging technologies. Improvement of heat transfer fluids requires a balance between experimental and numerical work in nanofluids and new refrigerants. Recognizing the uncertainties in development of new heat transfer fluids, *Advances in New Heat Transfer Fluids: From Numerical to Experimental Techniques* contains both theoretical and practical coverage.

Microscale and Nanoscale Heat Transfer: Analysis, Design, and Applications features contributions from prominent researchers in the field of micro- and nanoscale heat transfer and associated technologies and offers a complete understanding of thermal transport in nano-materials and devices. Nanofluids can be used as working fluids in thermal systems; the thermal conductivity of heat transfer fluids can be increased by adding nanoparticles in fluids. This book provides details of experimental and theoretical investigations made on nanofluids for use in the biomechanical and aerospace industries. It examines the use of nanofluids in improving heat transfer rates, covers the numerical approaches for computational fluid dynamics (CFD) simulation of nanofluids, and reviews the experimental results of commonly used nanofluids dispersed in both spherical and nonspherical nanoparticles. It also focuses on current and developing applications of microscale and nanoscale convective heat transfer. In addition, the book covers a wide range of analysis that includes: Solid-liquid interface phonon transfer at the molecular level The validity of the continuum hypothesis and Fourier law in nanochannels Conventional methods of using molecular dynamics (MD) for heat transport problems The molecular dynamics approach to calculate interfacial thermal resistance (ITR) A review of experimental results in the field of heat pipes and two-phase flows in thermosyphons Microscale convective heat transfer with gaseous flow in ducts The application of the lattice Boltzmann method for thermal microflows A numerical method for resolving the problem of subcooled convective boiling flows in microchannel heat sinks Two-phase boiling flow and condensation heat transfer in mini/micro channels, and more *Microscale and Nanoscale Heat Transfer: Analysis, Design, and Applications* addresses the need for thermal packaging and management for use in cooling electronics and serves as a resource for researchers, academicians, engineers, and other professionals working in the area of heat transfer, microscale and nanoscale science and engineering, and related industries.

Applications of Nanofluid for Heat Transfer Enhancement William Andrew

Five early papers evolve theory that won Einstein a Nobel Prize: "Movement of Small Particles Suspended in a Stationary Liquid Demanded by the Molecular-Kinetic Theory of Heat"; "On the Theory of the Brownian Movement"; "A New Determination of Molecular Dimensions"; "Theoretical Observations on the Brownian Motion"; and "Elementary Theory of the Brownian Motion." This book covers synthesis, characterization, stability, heat transfer and applications of nanofluids. It includes different types of nanofluids, their preparation methods as well as its effects on the stability and thermophysical properties of nanofluids. It provides a discussion on the mechanism behind the change in the thermal properties of nanofluids and heat transfer behaviour. It presents the latest information and discussion on the preparation and advanced characterization of nanofluids. It also consists of stability

analysis of nanofluids and discussion on why it is essential for the industrial application. The book provides a discussion on thermal boundary layer properties in convection. Future directions for heat transfer applications to make the production and application of nanofluids at industrial level are also discussed. .

Studies of fluid flow and heat transfer in a porous medium have been the subject of continuous interest for the past several decades because of the wide range of applications, such as geothermal systems, drying technologies, production of thermal isolators, control of pollutant spread in groundwater, insulation of buildings, solar power collectors, design of nuclear reactors, and compact heat exchangers, etc. There are several models for simulating porous media such as the Darcy model, Non-Darcy model, and non-equilibrium model. In porous media applications, such as the environmental impact of buried nuclear heat-generating waste, chemical reactors, thermal energy transport/storage systems, the cooling of electronic devices, etc., a temperature discrepancy between the solid matrix and the saturating fluid has been observed and recognized.

Nanofluids are gaining the attention of scientists and researchers around the world. This new category of heat transfer medium improves the thermal conductivity of fluid by suspending small solid particles within it and offers the possibility of increased heat transfer in a variety of applications. Bringing together expert contributions from across the globe, Heat Transfer Enhancement with Nanofluids presents a complete understanding of the application of nanofluids in a range of fields and explains the main techniques used in the analysis of nanofluids flow and heat transfer. Providing a rigorous framework to help readers develop devices employing nanofluids, the book addresses basic topics that include the analysis and measurements of thermophysical properties, convection, and heat exchanger performance. It explores the issues of convective instabilities, nanofluids in porous media, and entropy generation in nanofluids. The book also contains the latest advancements, innovations, methodologies, and research on the subject. Presented in 16 chapters, the text: Discusses the possible mechanisms of thermal conduction enhancement Reviews the results of a theoretical analysis determining the anomalous enhancement of heat transfer in nanofluid flow Assesses different approaches modeling the thermal conductivity enhancement of nanofluids Focuses on experimental methodologies used to determine the thermophysical properties of nanofluids Analyzes forced convection heat transfer in nanofluids in both laminar and turbulent convection Highlights the application of nanofluids in heat exchangers and microchannels Discusses the utilization of nanofluids in porous media Introduces the boiling of nanofluids Treats pool and flow boiling by analyzing the effect of nanoparticles on these complex phenomena Indicates future research directions to further develop this area of knowledge, and more Intended as a reference for researchers and engineers working in the field, Heat Transfer Enhancement with Nanofluids presents advanced topics that detail the strengths, weaknesses, and potential future developments in nanofluids heat transfer.

In the wake of energy crisis due to rapid growth of industries, the efficient heat transfer could play a vital role in energy saving. Industries, household equipment, transportation, offices, etc., all are dependent on heat exchanging equipment. Considering this, the book has incorporated different chapters on heat transfer phenomena, analytical and experimental heat transfer investigations, heat transfer enhancement and applications.

Nanofluids for Heat and Mass Transfer: Fundamentals, Sustainable Manufacturing and Applications presents the latest on the performance of nanofluids in heat transfer systems. Dr. Bharat Bhanvase investigates characterization techniques and the various properties of nanofluids to analyze their efficiency and abilities in a variety of settings. The book moves through a presentation of the fundamentals of synthesis and nanofluid characterization to various properties and applications. Aimed at academics and researchers focused on heat transfer in energy and engineering disciplines, this book considers sustainable manufacturing processes within newer energy harvesting technologies to serve as an authoritative and well-rounded reference. Highlights the major elements of nanofluids as an energy harvesting fluid, including their preparation methods, characterization techniques, properties and applications Includes valuable findings and insights from numerical and computational studies Provides nanofluid researchers with research inspiration to discover new applications and further develop technologies

Featuring contributions by leading researchers in the field, Nanoparticle Heat Transfer and Fluid Flow explores heat transfer and fluid flow processes in nanomaterials and nanofluids, which are becoming increasingly important across the engineering disciplines. The book covers a wide range, from biomedical and energy conversion applications to materials properties, and addresses aspects that are essential for further progress in the field, including numerical quantification, modeling, simulation, and presentation. Topics include: A broad review of nanofluid applications, including industrial heat transfer, biomedical engineering, electronics, energy conversion, membrane filtration, and automotive An overview of thermofluids and their importance in biomedical applications and heat-transfer enhancement A deeper look at biomedical applications such as nanoparticle hyperthermia treatments for cancers Issues in energy conversion from dispersed forms to more concentrated and utilizable forms Issues in nanofluid properties, which are less predictable and less repeatable than those of other media that participate in fluid flow and heat transfer Advances in computational fluid dynamic (CFD) modeling of membrane filtration at the microscale The role of nanofluids as a coolant in microchannel heat transfer for the thermal management of electronic equipment The potential enhancement of natural convection due to nanoparticles Examining key topics and applications in nanoscale heat transfer and fluid flow, this comprehensive book presents the current state of the art and a view of the future. It offers a valuable resource for experts as well as newcomers interested in developing innovative modeling and numerical simulation in this growing field.

In the present book, nanofluid heat and mass transfer in engineering problems are investigated. The use of additives in the base fluid like water or ethylene glycol is one of the techniques applied to augment heat transfer. Newly, innovative nanometer-sized particles have been dispersed in the base fluid in heat transfer fluids. The fluids containing the solid nanometer-sized particle dispersion are called "nanofluids." At first, nanofluid heat and mass transfer over a stretching sheet are provided with various boundary conditions. Problems faced for simulating nanofluids are reported. Also, thermophysical properties of various nanofluids are presented. Nanofluid flow and heat transfer in the presence of magnetic field are investigated. Furthermore, applications for electrical and biomedical engineering are provided. Besides, applications of nanofluid in internal combustion engine are provided. Different numerical and analytical methods have been employed to find the solution of governing equations for nanofluid flow and heat transfer. Applications of Nanofluid Transportation and Heat Transfer Simulation provides emerging research exploring the theoretical and practical aspects and applications of heat and nanofluid transfer. With practical examples and proposed methodology, it features coverage on a broad range of topics such as nanoparticles, electric fields, and hydrothermal behavior, making it an ideal reference source for engineers, researchers, graduate students,

professionals, and academics.

Featuring contributions from the renowned researchers and academicians in the field, this book covers key conventional and emerging cooling techniques and coolants for electronics cooling. It includes following thematic topics: - Cooling approaches and coolants - Boiling and phase change-based technologies - Heat pipes-based cooling - Microchannels cooling systems - Heat loop cooling technology - Nanofluids as coolants - Theoretical development for the junction temperature of package chips. This book is intended to be a reference source and guide to researchers, engineers, postgraduate students, and academicians in the fields of thermal management and cooling technologies as well as for people in the electronics and semiconductors industries.

Convective Flow and Heat Transfer from Wavy Surfaces: Viscous Fluids, Porous Media, and Nanofluids addresses the wavy irregular surfaces in heat transfer devices. Fluid flow and heat transfer studies from wavy surfaces have received attention, since they add complexity and require special mathematical techniques. This book considers the flow and heat transfer characteristics from wavy surfaces, providing an understanding of convective behavioral changes.

Introduction to nanofluids--their properties, synthesis, characterization, and applications Nanofluids are attracting a great deal of interest with their enormous potential to provide enhanced performance properties, particularly with respect to heat transfer. In response, this text takes you on a complete journey into the science and technology of nanofluids. The authors cover both the chemical and physical methods for synthesizing nanofluids, explaining the techniques for creating a stable suspension of nanoparticles. You get an overview of the existing models and experimental techniques used in studying nanofluids, alongside discussions of the challenges and problems associated with some of these models. Next, the authors set forth and explain the heat transfer applications of nanofluids, including microelectronics, fuel cells, and hybrid-powered engines. You also get an introduction to possible future applications in large-scale cooling and biomedicine. This book is the work of leading pioneers in the field, one of whom holds the first U.S. patent for nanofluids. They have combined their own first-hand knowledge with a thorough review of the literature. Among the key topics are: * Synthesis of nanofluids, including dispersion techniques and characterization methods * Thermal conductivity and thermo-physical properties * Theoretical models and experimental techniques * Heat transfer applications in microelectronics, fuel cells, and vehicle engines This text is written for researchers in any branch of science and technology, without any prerequisite. It therefore includes some basic information describing conduction, convection, and boiling of nanofluids for those readers who may not have adequate background in these areas. Regardless of your background, you'll learn to develop nanofluids not only as coolants, but also for a host of new applications on the horizon.

Control volume finite element methods (CVFEM) bridge the gap between finite difference and finite element methods, using the advantages of both methods for simulation of multi-physics problems in complex geometries. In Hydrothermal Analysis in Engineering Using Control Volume Finite Element Method, CVFEM is covered in detail and applied to key areas of thermal engineering. Examples, exercises, and extensive references are used to show the use of the technique to model key engineering problems such as heat transfer in nanofluids (to enhance performance and compactness of energy systems), hydro-magnetic techniques in materials and bioengineering, and convective flow in fluid-saturated porous media. The topics are of practical interest to engineering, geothermal science, and medical and biomedical sciences. Introduces a detailed explanation of Control Volume Finite Element Method (CVFEM) to provide for a complete understanding of the fundamentals Demonstrates applications of this method in various fields, such as nanofluid flow and heat transfer, MHD, FHD, and porous media Offers complete familiarity with the governing equations in which nanofluid is used as a working fluid Discusses the governing equations of MHD and FHD Provides a number of extensive examples throughout the book Bonus appendix with sample computer code

This book focuses on the use of nanotechnology in several fields of engineering. Among others, the reader will find valuable information as to how nanotechnology can aid in extending the life of component materials exposed to corrosive atmospheres, in thermal fluid energy conversion processes, anti-reflection coatings on photovoltaic cells to yield enhanced output from solar cells, in connection with friction and wear reduction in automobiles, and buoyancy suppression in free convective heat transfer. Moreover, this unique resource presents the latest research on nanoscale transport phenomena and concludes with a look at likely future trends.

Applications of Nanofluid for Heat Transfer Enhancement explores recent progress in computational fluid dynamic and nonlinear science and its applications to nanofluid flow and heat transfer. The opening chapters explain governing equations and then move on to discussions of free and forced convection heat transfers of nanofluids. Next, the effect of nanofluid in the presence of an electric field, magnetic field, and thermal radiation are investigated, with final sections devoted to nanofluid flow in porous media and application of nanofluid for solidification. The models discussed in the book have applications in various fields, including mathematics, physics, information science, biology, medicine, engineering, nanotechnology, and materials science. Presents the latest information on nanofluid free and force convection heat transfer, of nanofluid in the presence of thermal radiation, and nanofluid in the presence of an electric field Provides an understanding of the fundamentals in new numerical and analytical methods Includes codes for each modeling method discussed, along with advice on how to best apply them

Handbook of Nanomaterials for Industrial Applications explores the use of novel nanomaterials in the industrial arena. The book covers nanomaterials and the techniques that can play vital roles in many industrial procedures, such as increasing sensitivity, magnifying precision and improving production limits. In addition, the book stresses that these approaches tend to provide green, sustainable solutions for industrial developments. Finally, the legal, economical and toxicity aspects of nanomaterials are covered in detail, making this is a comprehensive, important resource for anyone wanting to learn more about how nanomaterials are changing the way we create products in modern industry.

Demonstrates how cutting-edge developments in nanomaterials translate into real-world innovations in a range of

industry sectors Explores how using nanomaterials can help engineers to create innovative consumer products
Discusses the legal, economical and toxicity issues arising from the industrial applications of nanomaterials
Heat transfer calculations in different aspects of engineering applications are essential to aid engineering design of heat exchanging equipment. Minimizing of computational time is a challenging task faced by researchers and users. Methodology of calculations in some application areas are incorporated in this book, such as differential analysis of heat recoveries with CFD in a tube bank, heating and ventilation of equipment and methods for analytical solution of nonlinear problems. Numerical analysis is the prerequisite of design and for the manufacture of heat exchanging equipment. Some numerical and experimental information are presented with utmost skill. Similarly, the analytical solution of heat transfer is touched in this book. Study of heat transfer phenomena and applications are equally emphasized in this issue.

With Application of Nonlinear Systems in Nanomechanics and Nanofluids the reader gains a deep and practice-oriented understanding of nonlinear systems within areas of nanotechnology application as well as the necessary knowledge enabling the handling of such systems. The book helps readers understand relevant methods and techniques for solving nonlinear problems, and is an invaluable reference for researchers, professionals and PhD students interested in research areas and industries where nanofluidics and dynamic nano-mechanical systems are studied or applied. The book is useful in areas such as nanoelectronics and bionanotechnology, and the underlying framework can also be applied to other problems in various fields of engineering and applied sciences. Provides comprehensive coverage of nano-dynamical systems and their specialized processes and applications in the context of nonlinear differential equations and analytical methods Enables researchers and engineers to better model, interpret and control nanofluidics and other nano-dynamical systems and their application processes Explains nano-dynamical systems by means of describing 'real-life' application case studies

In three handy volumes, this ready reference provides a detailed overview of nanotechnology as it is applied to energy sustainability. Clearly structured, following an introduction, the first part of the book is dedicated to energy production, renewable energy, energy storage, energy distribution, and energy conversion and harvesting. The second part then goes on to discuss nano-enabled materials, energy conservation and management, technological and intellectual property-related issues and markets and environmental remediation. The text concludes with a look at and recommendations for future technology advances. An essential handbook for all experts in the field - from academic researchers and engineers to developers in industry.

In the wake of energy crisis due to rapid growth of industries, urbanization, transportation, and human habit, the efficient transfer of heat could play a vital role in energy saving. Industries, household requirements, offices, transportation are all dependent on heat exchanging equipment. Considering these, the present book has incorporated different sections related to general aspects of heat transfer phenomena, convective heat transfer mode, boiling and condensation, heat transfer to two phase flow and heat transfer augmentation by different means.

Preparation, Characterization, Properties and Application of Nanofluid begins with an introduction of colloidal systems and their relation to nanofluid. Special emphasis on the preparation of stable nanofluid and the impact of ultrasonication power on nanofluid preparation is also included, as are characterization and stability measurement techniques. Other topics of note in the book include the thermophysical properties of nanofluids as thermal conductivity, viscosity, and density and specific heat, including the figure of merit of properties. In addition, different parameters, like particle type, size, concentration, liquid type and temperature are discussed based on experimental results, along with a variety of other important topics. The available model and correlations used for nanofluid property calculation are also included. Provides readers with tactics on nanofluid preparation methods, including how to improve their stability Explores the effect of preparation method and stability on thermophysical and rheological properties of nanofluids Assesses the available model and correlations used for nanofluid property calculation

This book assists in the exchange of research and progress outcomes concerned with the latest issues in thermophysical properties (TPPs) of complex liquids research, development, and production. Topics cover the control of transport properties of metallic alloys, thermal analysis of complex plasmas and instabilities in plasma devices, thermophysical properties at nanolevel, theoretical background of viscosities of hydrocarbons at varying temperature and pressure ranges, molecular modeling, and experimental investigations based on nanofluids and ionic conduction in solid-state electrolytes for thermodynamic data. This book enables global researchers to tackle the challenges that continue to generate cost-effective TPPs and the latest understanding in the development of complex materials and the collaboration of modern thermophysical generating technologies. Moreover, it provides a platform for different regional authors to exchange scientific knowledge and generate enthusiasm for science and technology.

In the present book, various applications of microfluidics and nanofluidics are introduced. Microfluidics and nanofluidics span a broad array of disciplines including mechanical, materials, and electrical engineering, surface science, chemistry, physics and biology. Also, this book deals with transport and interactions of colloidal particles and biomolecules in microchannels, which have great importance to many microfluidic applications, such as drug delivery in life science, microchannel heat exchangers in electronic cooling, and food processing industry. Furthermore, this book focuses on a detailed description of the thermal transport behavior, challenges and implications that involve the development and use of HTFs under the influence of atomistic-scale structures and industrial applications.

Applications of Nanofluid for Heat Transfer Enhancement explores recent progress in computational fluid dynamic and nonlinear science and its applications to nanofluid flow and heat transfer. The opening chapters explain the governing equations. Then, free and forced convection heat transfers of nanofluid are covered. Furthermore, the effect of nanofluid in the presence of an electric field, magnetic field and thermal radiation are investigated. Finally, nanofluid flow in porous media and application of nanofluid for solidification are considered. The models discussed here have applications in various fields, including mathematics, physics, information science, biology, medicine, engineering, nanotechnology and materials science. Readers will gain familiarity with the governing equations of nanofluid free and force convection heat transfer, of nanofluid in presence of thermal radiation and nanofluid in presence of electric field Readers will gain an understanding of the fundamentals in new numerical and analytical methods in solving to the applications of nanofluid Includes codes for each modelling methods discussed, and advice on how to best apply them

Applications of Heat, Mass and Fluid Boundary Layers brings together the latest research on boundary layers where there has been remarkable advancements in recent years. This book highlights relevant concepts and solutions to energy issues and

environmental sustainability by combining fundamental theory on boundary layers with real-world industrial applications from, among others, the thermal, nuclear and chemical industries. The book's editors and their team of expert contributors discuss many core themes, including advanced heat transfer fluids and boundary layer analysis, physics of fluid motion and viscous flow, thermodynamics and transport phenomena, alongside key methods of analysis such as the Merk-Chao-Fagbenle method. This book's multidisciplinary coverage will give engineers, scientists, researchers and graduate students in the areas of heat, mass, fluid flow and transfer a thorough understanding of the technicalities, methods and applications of boundary layers, with a unified approach to energy, climate change and a sustainable future. Presents up-to-date research on boundary layers with very practical applications across a diverse mix of industries Includes mathematical analysis to provide detailed explanation and clarity Provides solutions to global energy issues and environmental sustainability

Nanofluid in Heat Exchanges for Mechanical Systems: Numerical Simulation shows how the finite volume method is used to simulate various applications of heat exchanges. Heat transfer enhancement methods are introduced in detail, along with a hydrothermal analysis and second law approaches for heat exchanges. The melting process in heat exchanges is also covered, as is the influence of variable magnetic fields on the performance of heat exchange. This is an important reference source for materials scientists and mechanical engineers who are looking to understand the main ways that nanofluid flow is simulated and applied in industry. Provides detailed coverage of major models used in nanofluid analysis, including the finite volume method, governing equations for turbulent flow, and equations of nanofluid in presence of variable magnetic field Offers detailed coverage of swirling flow devices and melting processes Assesses which models should be applied in which situations

As an emerging research field, nanofluids have sparked immense interest from researchers around the world and have been a subject of intensive research in recent years. Because of their fascinating thermophysical properties and heat transfer performances, as well as enormous potential applications, nanofluids are considered the next generation heat transfer fluids. This book covers a wide range of topics from preparation methodology, properties, and theories to applications of nanofluids. In addition to the state-of-the-art reviews and analysis on the key areas of nanofluids including thermophysical and heat transfer properties of carbon nanotube and magnetic nanofluids, viscosity of metal oxide nanofluids and pool boiling of nanofluids, this book presents extensive experimental and theoretical research efforts on thermal conductivity, viscosity, convective heat transfer, capillary wetting, and transport properties of nanofluids. Studies on the application of nanofluids in droplet-based microfluidic technology are presented. Another new area of nanofluid-based optical engineering is explored in this book. It also introduces a new class of nanofluids named-ionanofluids. Featuring contributions from some of the leading researchers in the field, this book is a unique reference source and an invaluable guide to scientists, researchers, engineers, industrial people, graduate and postgraduate students, as well as academicians across the science and engineering disciplines.

Most of engineering problems, especially heat transfer equations, are nonlinear, therefore some of them are solved using numerical solution and some are solved using different semi-analytic methods. There are several new semi-analytical methods, including homotopy perturbation method (HPM), Parameter perturbation method (PPM), Differential Transformation Method (DTM), hybrid differential transformation-finite difference (Hybrid-DTM), Adomian decomposition method (ADM), Homotopy Analysis Method (HAM), and Galerkin Optimal Homotopy Asymptotic Method (GOHAM). These methods can solve a large class of nonlinear problems efficiently, accurately and easily. In this book, semi-analytical methods are applied to solve a range of engineering problems. After the various methods are introduced, their application in nanofluid flow and heat transfer, magnetohydrodynamic flow, electrohydrodynamic flow and heat transfer, and nanofluid flow in porous media within several examples are explored. This will be a valuable reference resource for materials scientists and engineers, and will help familiarize them with a wide range of semi-analytical methods, and how they are used in nanofluid flow and heat transfer. The book also includes case studies to illustrate how these methods are used in practice. Readers will gain complete familiarity with governing equations where nanofluid is used as working fluid Readers will gain a thorough understanding of the fundamentals in new analytical methods in solving to the applications of nanofluid flow and heat transfer in presence of magnetic and electric field Gives a detailed overview of nanofluid motion in porous media

Titanium dioxide is mainly used as a pigment and photocatalyst. It is possible to find it in food, cosmetics, building materials, electric devices, and others. This book contains chapters about application of titanium dioxide in different branches of economy such as the agriculture, the food industry, the medicine, the cosmetics, the water treatment technologies, and the semiconductors. **Heat Transfer Enhancement Using Nanofluid Flow in Microchannels: Simulation of Heat and Mass Transfer** focuses on the numerical simulation of passive techniques, and also covers the applications of external forces on heat transfer enhancement of nanofluids in microchannels. Economic and environmental incentives have increased efforts to reduce energy consumption. Heat transfer enhancement, augmentation, or intensification are the terms that many scientists employ in their efforts in energy consumption reduction. These can be divided into (a) active techniques which require external forces such as magnetic force, and (b) passive techniques which do not require external forces, including geometry refinement and fluid additives. Gives readers the knowledge they need to be able to simulate nanofluids in a wide range of microchannels and optimise their heat transfer characteristics Contains real-life examples, mathematical procedures, numerical algorithms, and codes to allow readers to easily reproduce the methodologies covered, and to understand how they can be applied in practice Presents novel applications for heat exchange systems, such as entropy generation minimization and figures of merit, allowing readers to optimize the techniques they use Focuses on the numerical simulation of passive techniques, and also covers the applications of external forces on heat transfer enhancement of nanofluids in microchannels

Kirchhoff's laws give a mathematical description of electromechanics. Similarly, translational motion mechanics obey Newton's laws, while rotational motion mechanics comply with Euler's moment equations, a set of three nonlinear, coupled differential equations. Nonlinearities complicate the mathematical treatment of the seemingly simple action of rotating, and these complications lead to a robust lineage of research culminating here with a text on the ability to make rigid bodies in rotation become self-aware, and even learn. This book is meant for basic scientifically inclined readers commencing with a first chapter on the basics of stochastic artificial intelligence to bridge readers to very advanced topics of deterministic artificial intelligence, espoused in the book with applications to both electromechanics (e.g. the forced van der Pol equation) and also motion mechanics (i.e. Euler's moment equations). The reader will learn how to bestow self-awareness and express optimal learning methods for the self-aware object (e.g. robot) that require no tuning and no interaction with humans for autonomous operation. The topics learned from reading this text will prepare students and faculty to investigate interesting problems of mechanics. It is the fondest hope of

the editor and authors that readers enjoy the book.

Thermofluid Modeling for Sustainable Energy Applications provides a collection of the most recent, cutting-edge developments in the application of fluid mechanics modeling to energy systems and energy efficient technology. Each chapter introduces relevant theories alongside detailed, real-life case studies that demonstrate the value of thermofluid modeling and simulation as an integral part of the engineering process. Research problems and modeling solutions across a range of energy efficiency scenarios are presented by experts, helping users build a sustainable engineering knowledge base. The text offers novel examples of the use of computation fluid dynamics in relation to hot topics, including passive air cooling and thermal storage. It is a valuable resource for academics, engineers, and students undertaking research in thermal engineering. Includes contributions from experts in energy efficiency modeling across a range of engineering fields Places thermofluid modeling and simulation at the center of engineering design and development, with theory supported by detailed, real-life case studies Features hot topics in energy and sustainability engineering, including thermal storage and passive air cooling Provides a valuable resource for academics, engineers, and students undertaking research in thermal engineering

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