The Mathematical Theory Of Special And General Relativity

This mathematically rigorous treatment examines Zeeman's characterization of the causal automorphisms of Minkowski spacetime and the Penrose theorem concerning the apparent shape of a relativistically moving sphere. Other topics include the construction of a geometric theory of the electromagnetic field; an in-depth introduction to the theory of spinors; and a classification of electromagnetic fields in both tensor and spinor form. Appendixes introduce a topology for Minkowski spacetime and discuss Dirac's famous "Scissors Problem." Appropriate for graduate-level courses, this text presumes only a knowledge of linear algebra and elementary point-set topology. 1992 edition. 43 figures.

Linear and nonlinear waves are a central part of the theory of PDEs. This book begins with a description of one-dimensional waves and their visualization through computer-aided techniques. Next, traveling waves are covered, such as solitary waves for the Klein-Gordon and KdV equations. Finally, the author gives a lucid discussion of waves arising from conservation laws, including shock and rarefaction waves. As an application, interesting models of traffic flow are used to illustrate conservation laws and wave phenomena. This book is based on a course given by the author at the IAS/Park City Mathematics Institute. It is suitable for independent study by undergraduate students in mathematics, engineering, and science programs. This book is published in cooperation with IAS/Park City Mathematics Institute.

This introduction to the mathematical foundations of quantum field theory is based on operator algebraic methods and emphasizes the link between the mathematical formulations and related physical concepts. The book begins with a general probabilistic description of physics, encompassing both classical and quantum physics, and presents the key physical notions before introducing operator algebraic methods. Operator algebra is then used to develop the theory of special relativity, scattering theory, and sector theory.

Comprehensive text provides a detailed treatment of orthogonal polynomials, principal properties of the gamma function, hypergeometric functions, Legendre functions, confluent hypergeometric functions, and Hill's equation.

"The theory of black holes is the most simple consequence of Einstein's relativity theory. Dealing with relativity theory, this book details one of the most beautiful areas of mathematical physics; the theory of black holes. It represents a personal testament to the work of the author, who spent several years working-out the subject matter."--WorldCat.

This is an introduction to the mathematical foundations of quantum field theory, using operator algebraic methods and emphasizing the link between the mathematical formulations and related physical concepts. It starts with a general probabilistic description of physics, which encompasses both classical and quantum physics. The basic key physical notions are clarified at this point. It then introduces operator algebraic methods for quantum theory, and goes on to discuss the theory of special relativity, scattering theory, and sector theory in this context.

This monograph aims to lay the groundwork for the design of a unified mathematical approach to the modeling and analysis of large, complex systems composed of interacting living things.

Drawing on twenty years of research in various scientific fields, it explores how mathematical kinetic theory and evolutionary game theory can be used to understand the complex interplay between mathematical sciences and the dynamics of living systems. The authors hope this will contribute to the development of new tools and strategies, if not a new mathematical theory. The first chapter discusses the main features of living systems and outlines a strategy for their modeling. The following chapters then explore some of the methods needed to potentially achieve this in practice. Chapter Two provides a brief introduction to the mathematical kinetic theory of classical particles, with special emphasis on the Boltzmann equation; the Enskog equation, mean field models, and Monte Carlo methods are also briefly covered. Chapter Three uses concepts from evolutionary game theory to derive mathematical structures that are able to capture the complexity features of interactions within living systems. The book then shifts to exploring the relevant applications of these methods that can potentially be used to derive specific, usable models. The modeling of social systems in various contexts is the subject of Chapter Five, and an overview of modeling crowd dynamics is given in Chapter Six, demonstrating how this approach can be used to model the dynamics of multicellular systems. The final chapter considers some additional applications before presenting an overview of open problems. The authors then offer their own speculations on the conceptual paths that may lead to a mathematical theory of living systems hoping to motivate future research activity in the field. A truly unique contribution to the existing literature, A Quest Toward a Mathematical Theory of Living Systems is an important book that will no doubt have a significant influence on the future directions of the field. It will be of interest to mathematical biologists, systems biologists, biophysicists, and other researchers working on understanding the complexities of living systems.

This monograph has the ambitious aim of developing a mathematical theory of complex biological systems with special attention to the phenomena of ageing, degeneration and repair of biological tissues under individual self-repair actions that may have good potential in medical therapy. The approach to mathematically modeling biological systems needs to tackle the additional difficulties generated by the peculiarities of living matter. These include the lack of invariance principles, abilities to express strategies for individual fitness, heterogeneous behaviors, competition up to proliferative and/or destructive actions, mutations, learning ability, evolution and many others. Applied mathematicians in the field of living systems, especially biological systems, will appreciate the special class of integro-differential equations offered here for modeling at the molecular, celular and tissue scales. A unique perspective is also presented with a number of case studies in biological modeling.

Based on courses taught at the University of Dublin, Carnegie Mellon University, and mostly at Simon Fraser University, this book presents the special theory of relativity from a mathematical point of view. It begins with the axioms of the Minkowski vector space and the flat spacetime manifold. Then it discusses the kinematics of special relativity in terms of Lorentz tranformations, and treats the group structure of Lorentz transformations. Extending the discussion to spinors, the author shows how a unimodular mapping of spinor (vector) space can induce a proper, orthochronous Lorentz mapping on the Minkowski vector space. The second part begins with a discussion of relativistic particle mechanics from both the Lagrangian and Hamiltonian points of view. The book then turns to the relativistic (classical) field theory, including a proof of Noether's theorem and discussions of the Klein-Gordon, electromagnetic, Dirac, and non-abelian gauge fields. The final chapter deals with recent work on classical fields in an eight-dimensional covariant phase space.

This introduction to the theory of Sobolev spaces and Hilbert space methods in partial differential equations is geared toward readers of modest mathematical backgrounds. It offers coherent, accessible demonstrations of the use of these techniques in developing the foundations of the theory of finite element approximations. J. T. Oden is Director of the Institute for Computational Engineering & Sciences (ICES) at the University of Texas at Austin, and J. N. Reddy is a Professor of Engineering at Texas A&M University. They developed this essentially self-contained text from their seminars and courses for students with diverse educational backgrounds. Their effective presentation begins with introductory accounts of the theory of distributions, Sobolev spaces, intermediate spaces and duality, the theory of elliptic equations, and variational boundary value problems. The second half of the text explores the theory of finite element interpolation, finite element methods for elliptic equations, and finite element methods for initial boundary value problems. Detailed proofs of the major theorems appear throughout the text, in addition to numerous examples.

The general concept of information is here, for the first time, defined mathematically by adding one single axiom to the probability theory. This Mathematical Theory of Information is explored in fourteen chapters: 1. Information can be measured in different units, in anything from bits to dollars. We will here argue that any measure is acceptable if it does not violate the Law of Diminishing Information. This law is supported by two independent arguments: one derived from the Bar-Hillel ideal receiver, the other is based on Shannon's noisy channel. The entropy in the 'classical information theory' is one of the measures conforming to the Law of Diminishing Information, but it has, however, properties such as being symmetric, which makes it unsuitable for some applications. The measure reliability is found to be a universal information measure. 2. For discrete and finite signals, the Law of Diminishing Information is defined mathematically, using probability theory and matrix algebra. 3. The Law of Diminishing Information is used as an axiom to derive essential properties of information. Byron's law: there is more information in a lie than in gibberish. Preservation: no information is lost in a reversible channel. Etc. The Mathematical Theory of Information supports colligation, i. e. the property to bind facts together making 'two plus two greater than four'. Colligation is a must when the information carries knowledge, or is a base for decisions. In such cases, reliability is always a useful information measure. Entropy does not allow colligation.

Scientific knowledge grows at a phenomenal pace--but few books have had as lasting an impact or played as important a role in our modern world as The Mathematical Theory of Communication, published originally as a paper on communication theory more than fifty years ago. Republished in book form shortly thereafter, it has since gone through four hardcover and sixteen paperback printings. It is a revolutionary work, astounding in its foresight and contemporaneity. The University of Illinois Press is pleased and honored to issue this commemorative reprinting of a classic.

Unlike some other reproductions of classic texts (1) We have not used OCR(Optical Character Recognition), as this leads to bad quality books with introduced typos. (2) In books where there are images such as portraits, maps, sketches etc We have endeavoured to keep the quality of these images, so they represent accurately the original artefact. Although occasionally there may be certain imperfections with these old texts, we feel they deserve to be made available for future generations to enjoy.

With the objective of making into a science the art of verifying computer programs (debugging), the author addresses both practical and theoretical aspects. Subjects include computability (with discussions of finite automata and Turing machines); predicate calculus; verification of programs (bloth flowchart and algol-like programs); flowchart schemas; and the fixpoint theory of programs. 1974 edition. Includes 77 figures.

A special algebra is proposed for applied mathematics. A special algebra is developed specifically for discovering new theory inside the present theory of Special Relativity. In the book's climax, the special algebra unites Maxwell's Equations into the Dirac Equation to form a mathematical model of physics that combines the dynamics of a photon with the dynamics of an electron. An electron projects itself as a photon, per the application of the special algebra. The special algebra that leads to this climax is derived from a proof of irrationality of an irrational number. The place-value digits of an irrational number that are beyond a specific finite maximum in count are each unknown and unknowable, analogous to Schrödinger's Cat. Through use of the special algebra, the double existence of Schrödinger's Cat leads to the double existence of the electron/photon particle. The special algebra is derived from a proposed axiom that replaces Cantor's Continuum Hypothesis, from which the real numbers were derived. The mathematics is simple enough to be understood by a high school student who has taken first year level college math and physics classes (and is familiar with trigonometry and logarithms, complex numbers, matrix multiplication, geometric-unit-vectors, and partial differential equations). Visualizations and examples help the reader comprehend each subtle feature in the algebra. Each chapter has exercises so that the reader can check their comprehension. The book was written to be quickly read and easily understood, and the book includes the mathematical details. SPECIAL ALGEBRA FOR SPECIAL RELATIVITY o Derives a proper replacement for infinity for use in applied mathematics o Proposes a new theory for electromagnetism o Pushes hypercomplex number algebra to the extremes o Combines anti-matter, electromagnetism, matter-waves, and time-space Preface - The real numbers, defined per Cantor's Continuum Hypothesis, are replaced by a new set of numbers. The new set of numbers are defined per a proposed new axiom that is consistent with the proofs that specific numbers are irrational. By use of the mathematical operation of the Lorentz Transformation, the new set of numbers is applied to the existing mathematical model of the Dirac Equation to result in Maxwell's Equations. Unlike the real numbers, the new set of numbers has no dependency on an actual infinity. In base two, the new set of numbers has known or knowable place-value digits after the decimal point that extend to a finite count of place-value digits. Beyond that count, the place-value digits are unknown and unknowable. An unknown and unknowable place-value digit in base two is an analogy to Schrödinger's Cat. For example, in geometric space, the right triangle with two unit length sides has a finite imprecision to each unit length side because the quantity of zeros after the decimal point is a finite count. The quantity of zeros is not infinite per Cantor's theory of infinite sets, and is not the ultimate quantity of zeros as is assumed for an integer through the process of truncation at the decimal point. The length of the hypotenuse is similarly imprecise. The unknown and unknowable place-value digits after the decimal point cannot all be/become zero if replaced randomly with a one or a zero because there is no end to their count, and, therefore, a division reciprocal exists for the unknown and unknowable place-value digits. The division reciprocal is the proper replacement for an actual infinity because it may be used in applied mathematics. The division reciprocal is used in the Lorentz Transformation to model motion at the speed of light. The claim of applicability of the new set of numbers to applied mathematics is based on the correct calculation of the measured electromagnetic force density, by use of the complex conjugate of the Dirac Spinor.

This fascinating book is a treatise on real space-age materials. It is a mathematical treatment of a novel concept in material science that characterizes the properties of dynamic materials—that is, material substances whose properties are variable in space and time. Unlike conventional composites that are often found in nature, dynamic materials are mostly the products of modern technology developed to maintain the most effective control over dynamic processes.

This volume comprises two classic essays on the mathematical theories of elasticity and plasticity by authorities in this area of engineering science. Undergraduate and graduate students in engineering as well as professional engineers will find these works excellent texts and references. The Mathematical Theory of Elasticity covers plane stress and plane strain in the isotropic medium, holes and fillets of assignable shapes, approximate conformal mapping, reinforcement of holes, mixed boundary value problems, the third fundamental problem in two dimensions, eigensolutions for plane and axisymmetric states, anisotropic elasticity, thermal stress, elastic waves induced by thermal shock, three-dimensional contact problems, wave propagation, traveling loads and sources of disturbance, diffraction, and pulse propagation. The Mathematical Theory of Plasticity explores the theory of perfectly plastic solids, the theory of strain-hardening plastic solids, piecewise linear plasticity, minimum principles of plasticity, bending of a circular plate, and other problems.

Knots are familiar objects. We use them to moor our boats, to wrap our packages, to tie our shoes. Yet the mathematical theory of knots quickly leads to deep results in topology and geometry. The Knot Book is an introduction to this rich theory, starting from our familiar understanding of knots and a bit of college algebra and finishing with exciting topics of current research. The Knot Book is also about the excitement of doing mathematics. Colin Adams engages the reader with fascinating examples, superb figures, and thought-provoking ideas. He also presents the remarkable applications of knot theory to modern chemistry, biology, and physics. This is a compelling book that will comfortably escort you into the marvelous world of knot theory. Whether you are a mathematics student, someone working in a related field, or an amateur mathematician, you will find much of interest in The Knot Book.

The book expounds the major topics in the special theory of relativity. It provides a detailed examination of the mathematical foundation of the special theory of relativity, relativistic mass, relativistic mechanics and relativistic electrodynamics. As well as covariant formulation of relativistic mechanics and electrodynamics, the book discusses the relativistic effect on photons. Using a mathematical approach, the text offers graduate students a clear, concise view of the special theory of relativity. Organized into 14 chapters and two appendices, the content is presented in a logical order, and every topic has been dealt with in a simple and lucid manner. To aid understanding of the subject, the book provides numerous relevant worked examples in every chapter. The book’s mathematical approach helps students in their independent study and motivates them to research the topic further.

This book describes Carmeli's cosmological general and special relativity theory, along with Einstein's general and special relativity. These theories are discussed in the context of Moshe Carmeli's original research, in which velocity is introduced as an additional independent dimension. Four- and five-dimensional spaces are considered, and the five-dimensional braneworld theory is presented. The Tully-Fisher law is obtained directly from the theory, and thus it is found that there is no necessity to assume the existence of dark matter in the halo of galaxies, nor in galaxy clusters.The book gives the derivation of the Lorentz transformation, which is used in both Einstein's special relativity and Carmeli's cosmological special relativity theory. The text also provides the mathematical theory of curved spacetime geometry, which is necessary to describe both Einstein's general relativity and Carmeli's cosmological general relativity. A comparison between the dynamical and kinematic aspects of the expansion of the universe is made. Comparison is also made between the Friedmann-Robertson-Walker theory and the Carmeli theory. And neither is it necessary to assume the existence of dark matter to correctly describe the expansion of the cosmos.

Classic monograph presents connected account of mathematical theory of wave motion in a liquid with a free surface and subjected to gravitational and other forces, together with applications to concrete physical problems. 1957 edition.

This book presents the basic theory of relativity in a rational and simplest possible manner, with the emphasis on the Principle of Simplicity in developing the theory. The presentation is in the style of a discussion and is generally devoid of unproven and speculative assertions. In rare cases where speculative ideas are mentioned, they are clearly stated to be such. Test results verifying all of the theoretical results are given and discussed. This work is intended to serve as a resource and reference book for educational purposes. In Parts I and II the principal results of special and general relativity are derived rigorously, discussing the contributions of Einstein, as well as Lorentz, Poincare, Minkowski, Hilbert, Eddington and others, with historical notes touching upon the various aspects of relativity. Multiple derivations are given particularly of the mass-energy relation, the gravitational field equation, and the relativistic orbit of planets. The Schwarzschild metric and its consequences leading to the formation of black holes are treated in detail. The historical problems of physical dilation of time and Einstein's clock paradox are treated in an entirely new manner based upon general relativity. The author has also presented Einstein's gravitational radiation theory, and its application by Peters and Mathews to radiation from orbiting bodies, followed by the study of radiation from a certain binary pulsar by Weisberg and Taylor. These difficult topics are treated without taking shortcuts as is commonly done in textbooks, but in a manner that senior students can understand. A fresh look is taken of Weyl's unification of gravitational and electromagnetic field theories, again a difficult topic avoided by textbooks. The final chapter of Part II is on the elements of field cosmology. Aspects involving particle physics are not covered because they cannot be treated even cursorily in a book of this size dealing primarily with fields; only books specializing in cosmology can do justice to that vast subject. Part III is devoted entirely to tensor calculus, and its application to the geometries of Riemann and Weyl; these are the essential tools of Einstein's and Weyl's theories treated in Part II. Finally, four appendices are provided on certain mathematical topics. Thus the book is self-contained. The book contains 11 figures, an extensive bibliography and an index. Note: (1) Mathematical and other errors corrected March 21, 2015. (2) For earlier versions, a PDF of mathematical errata will be emailed upon request

for free. (3) Comments of readers are welcome and may be emailed to ashkatti34@gmail.com.
The topic of special functions, normally presented as a mere collection of functions exhibiting particular properties, is treated from a fresh and unusual perspective in this book. The authors have based the special functions on the theory of second-order ordinary differential equations in the complex domain. Several physical applications are presented. Numerous tables and figures will help the reader find his way through the subject.
An overview of special functions, focusing on the hypergeometric functions and the associated hypergeometric series.
This excellent 1981 treatment of the mathematical theory of entropy gives an accessible exposition its application to other fields.
The physicist and humanitarian took his place beside the great teachers with the publication of Relativity: The Special and General Theory, Einstein's own popular translation of the physics that shaped our "truths" of space and time.
This book has been considered by academicians and scholars of great significance and value to literature. This forms a part of the knowledge base for future generations. So that the book is never forgotten we have represented this book in a print format as the same form as it was originally first published. Hence any marks or annotations seen are left intentionally to preserve its true nature.
See the back of the book's cover for a description.