General Relativity A First Course For Physicists Prentice Hall International Series In Physics And Applied Physics

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Robert Geroch's lecture notes on general relativity are unique in three main respects. First, the physics of general relativity and the mathematics, which describes it, are masterfully intertwined in such a way that both reinforce each other to facilitate the understanding of the most abstract and subtle issues. Second, the physical phenomena are first properly explained in terms of spacetime and then it is shown how they can be 'decomposed' into familiar quantities, expressed in terms of space and time, which are measured by an observer. Third, Geroch's successful pedagogical approach to teaching theoretical physics through visualization of even the most abstract concepts is fully applied in his lectures on general relativity by the use of around a hundred figures. Although the book contains lecture notes written in 1972, it is (and will remain) an excellent introduction to general relativity, which covers its physical foundations, its mathematical formalism, the classical tests of its predictions, its application to cosmology, a number of specific and important issues (such as the initial value formulation of general relativity, signal propagation, time orientation, causality violation, singularity theorems, conformal transformations, and asymptotic structure of spacetime), and the early approaches to quantization of the gravitational field. Geroch's Differential Geometry: 1972 Lecture Notes can serve as a very helpful companion to this book

This textbook develops general relativity and its associated mathematics from a minimum of prerequisites, leading to a physical understanding of the theory in some depth.

A straightforward introduction to General Relativity, explaining the physical, philosophical and mathematical ideas it is built on.

The revised and updated 2nd edition of this established textbook provides a self-contained introduction to the general theory of relativity, describing not only the physical principles and applications of the theory, but also the mathematics needed, in particular the calculus of differential forms. Updated throughout, the book contains more detailed explanations and extended discussions of several conceptual points, and strengthened mathematical deductions where required. It includes examples of work conducted in the ten years since the first edition of the book was published, for example the pedagogically helpful concept of a "river of space" and a more detailed discussion of how far the principle of relativity is contained in the general theory of relativity. Also presented is a discussion of the concept of the 'gravitational field' in Einstein's theory, and some new material concerning the 'twin paradox' in the theory of relativity. Finally, the book contains a new section about gravitational waves, exploring the dramatic progress in this field following the LIGO observations. Based on a long-established masters course, the book

serves advanced undergraduate and graduate level students, and also provides a useful reference for researchers.
For physicists and applied mathematicians working in the fields of relativity and cosmology, high-energy physics and field theory, thermodynamics, fluid dynamics and mechanics. This book provides an introduction to the concepts and techniques of modern differential theory, particularly Lie groups, Lie forms and differential forms.
This book presents a comprehensive and self-contained exposition of the mathematical theory of impulsive light-like signals in general relativity. Applications are provided in relativistic astrophysics, cosmology and alternative theories of gravity deduced from string theory. Cataclysmic astrophysical events give rise to impulsive light-like signals which can generally be decomposed into a thin shell of null matter and an impulsive gravitational wave. Several examples are considered in black hole physics, wave collisions and light-like boosts of compact gravitating sources. Graduate students and researchers in relativistic astrophysics, cosmology and string theory will find this book very useful. Contents: General Description of an Impulsive Light-Like Signal; Illustrations and Implications of the Bianchi Identities; Light-Like Boosts of Gravitating Bodies; Spherically Symmetric Null Shells; Collisions of Plane Impulsive Light-Like Signals; Impulsive Light-Like Signals in Alternative Theories of Gravity. Readership: Researchers, graduate students and upper-level undergraduates interested in general relativity.
“General Relativity Without Calculus” offers a compact

but mathematically correct introduction to the general theory of relativity, assuming only a basic knowledge of high school mathematics and physics. Targeted at first year undergraduates (and advanced high school students) who wish to learn Einstein's theory beyond popular science accounts, it covers the basics of special relativity, Minkowski space-time, non-Euclidean geometry, Newtonian gravity, the Schwarzschild solution, black holes and cosmology. The quick-paced style is balanced by over 75 exercises (including full solutions), allowing readers to test and consolidate their understanding.

The theory of relativity is tackled directly in this book, dispensing with the need to establish the insufficiency of Newtonian mechanics. This book takes advantage from the start of the geometrical nature of the relativity theory. The reader is assumed to be familiar with vector calculus in ordinary three-dimensional Euclidean space.

General relativity is now an essential part of undergraduate and graduate courses in physics, astrophysics and applied mathematics. This simple, user-friendly introduction to relativity is ideal for a first course in the subject. Beginning with a comprehensive but simple review of special relativity, the book creates a framework from which to launch the ideas of general relativity. After describing the basic theory, it moves on to describe important applications to astrophysics, black hole physics, and cosmology. Several worked examples, and numerous figures and images, help students appreciate the underlying concepts. There are also 180 exercises which test and develop students' understanding of the subject. The textbook presents all the necessary information and discussion for an elementary approach to relativity. Password-protected solutions to the exercises are available to instructors at www.cambridge.org/9780521735612.

A First Course in General RelativityCambridge University Press

Never HIGHLIGHT a Book Again Virtually all testable terms, concepts, persons, places, and events are included. Cram101 Textbook Outlines gives all of the outlines, highlights, notes for your textbook with optional online practice tests. Only Cram101 Outlines are Textbook Specific. Cram101 is NOT the Textbook. Accompanys: 9780521673761

Based on a course taught for years at Oxford, this book offers a concise exposition of the central ideas of general relativity. The focus is on the chain of reasoning that leads to the relativistic theory from the analysis of distance and time measurements in the presence of gravity, rather than on the underlying mathematical structure. Includes links to recent developments, including theoretical work and observational evidence, to encourage further study.

This volume is made up of papers presented at the Conference on Classical General Relativity held at the City University, London, in December 1983. New tests, arising from space experimentation, pulsars and black holes have revitalised the study of Einstein's theory of gravitation (classical general relativity). Nineteen contributors survey recent progress and identify future avenues of research.

Second edition of a widely-used textbook providing the first step into general relativity for undergraduate students with minimal mathematical background.

This textbook is suitable for a one-semester introduction to General Relativity for advanced undergraduates in physics and engineering. The book is concise so that the entire material can be covered in the one-semester time frame. Besides, the readers are introduced to the subject easily without the need for advanced mathematics. Though concise, the theory development is lucid and the readers are exposed to possible analytic calculations. Full solutions to some important problems are provided, and the experimental evidence is discussed in detail. Contents:Review of Special RelativityVectors and Tensors in SpacetimeCovariant Differentiation, Equations of MotionCurvatureGravity and General RelativitySolar System Tests of General RelativityBlack HolesGravitational WavesCosmolgy Readership: Undergraduate and graduate students in physics courses.

An advanced textbook providing a clear mathematical introduction to general relativity and its physical applications. Vectors, tensors and functions -- Manifolds, vectors and differentiation -- Energy, momentum and Einstein's equations

Einstein's general theory of relativity is introduced in this advanced undergraduate textbook. Without an over emphasis on the difficult mathematics of tensor analysis, the book presents the curved spacetime theory of gravitation. The phenomena of gravitational light deflection, the precession of a planet's orbit, and black holes are discussed with technical detail. The book has an extensive treatment of cosmology from primordial inflation, cosmic microwavebackground to the dark energy that propels an accelerating universe. The book is the undergraduate edition of the author's previous work, Relativity, Gravitation and Cosmology: A Basic

Introduction,published as part of the Oxford Master Series in Physics. This college edition concentrates on the core elements of the subject making it suitable for a one-semester course at the undergraduate level. It can also serve as an accessible introduction to general relativity and cosmology for those readers who want to study the subject on their own.
In the late 20th and beginning 21st century high-precision astronomy, positioning and metrology strongly rely on general relativity. Supported by exercises and solutions this book offers graduate students and researchers entering those fields a self-contained and exhaustive but accessible treatment of applied general relativity. The book is written in a homogenous (graduate level textbook) style allowing the reader to understand the arguments step by step. It first introduces the mathematical and theoretical foundations of gravity theory and then concentrates on its general relativistic applications: clock rates, clock sychronization, establishment of time scales, astronomical references frames, relativistic astrometry, celestial mechanics and metrology. The authors present up-to-date relativistic models for applied techniques such as Satellite LASER Ranging (SLR), Lunar LASER Ranging (LLR), Globale Navigation Satellite Systems (GNSS), Very Large Baseline Interferometry (VLBI), radar measurements, gyroscopes and pulsar timing. A list of acronyms helps the reader keep an overview and a mathematical appendix provides required functions and terms.
This book explores the use of numerical relativity (NR) methods to solve cosmological problems, and describes one of the first uses of NR to study inflationary physics. NR consists in the solution of Einstein's Equation of general relativity, which governs the evolution of matter and energy on cosmological scales, and in systems where there are strong gravitational effects, such as around black holes. To

date, NR has mainly been used for simulating binary black hole and neutron star mergers like those detected recently by LIGO. Its use as a tool in fundamental problems of gravity and cosmology is novel, but rapidly gaining interest. In this thesis, the author investigates the initial condition problem in early universe cosmology – whether an inflationary expansion period could have "got going" from initially inhomogeneous conditions – and identifies criteria for predicting the robustness of particular models. State-of-the-art numerical relativity tools are developed in order to address this question, which are now publicly available.

This contributed volume explores the renaissance of general relativity after World War II, when it transformed from a marginal theory into a cornerstone of modern physics. Chapters explore key historical processes related to the theory of general relativity, in addition to presenting a thorough treatment of the relevant science behind these episodes. A broad historiographical framework is introduced first, thus providing the broad context in which the given computational approaches and case studies occurred. Written by an international and interdisciplinary group of expert authors, these chapters will bring readers to a more complete understanding of Einstein's theory. Specific topics include: Social and citation networks The Fock-Infeld dispute Wheeler's turn to gravitation theory The position of general relativity in theories of fundamental interactions The pursuit of a quantum theory of gravity The emergence of dark matter in relation to cosmological models Institutional frameworks for gravitational wave search in Europe The Renaissance of General Relativity in Context is ideal for historians, philosophers, and sociologists of science. Students and researchers in physics will also be interested in the topics explored.

Following the approach of Lev Landau and Evgenii Lifshitz, this book introduces the theory of special and general relativity with the Lagrangian formalism and the principle of least action. This method allows the complete theory to be constructed starting from a small number of assumptions, and is the most natural approach in modern theoretical physics. The book begins by reviewing Newtonian mechanics and Newtonian gravity with the Lagrangian formalism and the principle of least action, and then moves to special and general relativity. Most calculations are presented step by step, as is done on the board in class. The book covers recent advances in gravitational wave astronomy and provides a general overview of current lines of research in gravity. It also includes numerous examples and problems in each chapter.

The Mathematics of Relativity for the Rest of Us is intended to give the generally educated reader a thorough and factual understanding of Einstein's theory of relativity - including the difficult mathematical concepts, even if the reader is not trained in higher mathematics.

This book provides an in-depth and accessible description of special relativity and quantum mechanics which together form the foundation of 21st century physics. A novel aspect is that symmetry is given its rightful prominence as an integral part of this foundation. The book offers not only a conceptual understanding of symmetry, but also the mathematical tools necessary for quantitative analysis. As such, it provides a valuable precursor to more focused, advanced books on special relativity or quantum mechanics. Students are introduced to several topics not typically covered until much later in their education.These include space-time diagrams, the action principle, a proof of Noether's theorem, Lorentz vectors and tensors, symmetry breaking and general relativity. The book also provides extensive descriptions on topics of current general interest such as gravitational waves, cosmology, Bell's theorem, entanglement and quantum computing. Throughout the text, every opportunity is taken to emphasize the intimate connection between physics, symmetry and mathematics.The style remains light despite the rigorous and intensive content. The book is intended as a stand-alone or supplementary physics text for a one or two semester course for students who have completed an introductory calculus course and a first-year physics course that includes Newtonian mechanics and some electrostatics. Basic knowledge of linear algebra is useful but not essential, as all requisite mathematical background is provided either in the body of the text or in the Appendices. Interspersed through the text are well over a hundred worked examples and unsolved exercises for the student.

Do you know the basics of general relativity? Do you want to know something of what more there is? Do you wonder how the theory of relativity came into being? Then this book is for you! Partial contents: - Black holes and gravitational collapse - Cosmological solutions of Einstein's field equations - Gravitational waves - Space-time singularities - The problem of motion for massive particles - A collection of exact solutions of Einstein's field equations - A history of Einstein's creation of the theory of relativity in the years 1905-1915 - A short course for repetition of the basics of general relativity - Bibliography, references, and index The book, although not very advanced, covers a number of topics not often seen in text books. The selection, of course, refelects my own interests. The different chapters may to a large extent, though not completely, be read in any desired order. The author has a PhD in theoretical physics and is lecturer of mathematics. He has for many years taught physics and mathematics at senior high school as well as university level.

Suitable as a one-semester course in general relativity for senior undergraduates or beginning graduates, this text clarifies the mathematical aspects of Einsteins general theory of relativity without sacrificing physical understanding. Beginning with an exposition of those aspects of tensor calculus and differential geometry needed for a proper exposition of the subject, the discussion turns to the space-time of general relativity and to geodesic motion, comparisons and contrasts, with Newtons theory being drawn where appropriate. A brief consideration of the field equations is followed by a discussion of physics in the vicinity of massive objects, including an elementary treatment of black holes. The book concludes with brief, introductory chapters on gravitational radiation and cosmology, and includes an appendix that reviews the special theory of relativity. In preparing this new edition, the authors have completely rewritten chapters to make the material readily accessible to physics students, while many examples, exercises and problems help guide the students through the theory.

Suitable for a one-semester course in general relativity for senior undergraduates or beginning graduate students, this text clarifies the mathematical aspects of Einstein's theory of relativity without sacrificing physical understanding.

This book provides a completely revised and expanded version of the previous classic edition ‘General Relativity and Relativistic Astrophysics’. In Part I the foundations of general relativity are thoroughly developed, while Part

II is devoted to tests of general relativity and many of its applications. Binary pulsars – our best laboratories for general relativity – are studied in considerable detail. An introduction to gravitational lensing theory is included as well, so as to make the current literature on the subject accessible to readers. Considerable attention is devoted to the study of compact objects, especially to black holes. This includes a detailed derivation of the Kerr solution, Israel's proof of his uniqueness theorem, and a derivation of the basic laws of black hole physics. Part II ends with Witten's proof of the positive energy theorem, which is presented in detail, together with the required tools on spin structures and spinor analysis. In Part III, all of the differential geometric tools required are developed in detail. A great deal of effort went into refining and improving the text for the new edition. New material has been added, including a chapter on cosmology. The book addresses undergraduate and graduate students in physics, astrophysics and mathematics. It utilizes a very well structured approach, which should help it continue to be a standard work for a modern treatment of gravitational physics. The clear presentation of differential geometry also makes it useful for work on string theory and other fields of physics, classical as well as quantum.

Explore spectacular advances in contemporary physics with this unique celebration of the centennial of Einstein's discovery of general relativity.

Aimed at advanced undergraduates with background knowledge of classical mechanics and electricity and magnetism, this textbook presents both the particle dynamics relevant to general relativity, and the field dynamics necessary to understand the theory. Focusing on action extremization, the book develops the structure and predictions of general relativity by analogy with familiar physical systems. Topics ranging from classical field theory to minimal surfaces and relativistic strings are covered in a homogeneous manner. Nearly 150 exercises and numerous examples throughout the textbook enable students to test their understanding of the material covered. A tensor manipulation package to help students overcome the computational challenge associated with general relativity is available on a site hosted by the author. A link to this and to a solutions manual can be found at www.cambridge.org/9780521762458.

A textbook-neutral problems-and-solutions book that complements any relativity textbook at advanced undergraduate or masters level.

Gravitational physics has now become a mainstream topic in physics and physics teaching. In particular cosmology and gravitational wave physics are at the focus of a great deal of current research. Thus it is important to introduce students to General Relativity as soon as reasonable. This textbook offers a brief but comprehensive treatment accessible to advanced undergraduate students, graduate students, and any physicist or mathematician interested in understanding the material in a short time. The author, an experienced teacher of the subject, has included numerous examples and exercises to help students consolidate the ideas they have learned.