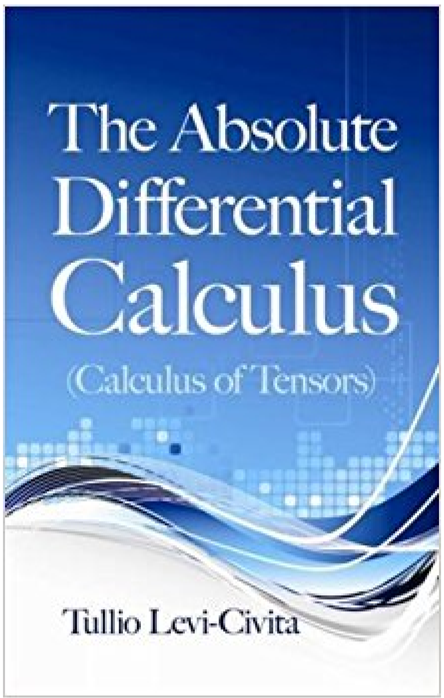
The Absolute Differential Calculus (Calculus Of Tensors) (Dover Books On Mathematics)



Synopsis

Written by a towering figure of twentieth-century mathematics, this classic examines the mathematical background necessary for a grasp of relativity theory. Tullio Levi-Civita provides a thorough treatment of the introductory theories that form the basis for discussions of fundamental quadratic forms and absolute differential calculus, and he further explores physical applications.Part one opens with considerations of functional determinants and matrices, advancing to systems of total differential equations, linear partial differential equations, algebraic foundations, and a geometrical introduction to theory. The second part addresses covariant differentiation, curvature-related Riemann's symbols and properties, differential quadratic forms of classes zero and one, and intrinsic geometry. The final section focuses on physical applications, covering gravitational equations and general relativity.

Book Information

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Customer Reviews

Text: English, Italian (translation)

Italian mathematician Tullio Levi-Civita (1873â “1941) is most famous for his work on absolute differential calculus and its applications to relativity theory.

This authorised English translation of a 1923 work by Tullio Levi-Civita has enormous historical significance in the development of differential geometry and general relativity. But it is not useful as part of a modern education in DG and GR.This hard-back Dover book "The Absolute Differential Calculus: Calculus of Tensors" (ISBN 978-0-486-44637-0) is of limited value now, and I think that the $70 RRP is a bit excessive, but it is interesting to see how DG was understood when it was more a branch of classical analysis than a branch of geometry or topology. The title indicates clearly the old way of thinking, namely that DG was a branch of calculus (i.e. classical analysis).Much of modern DG uses perplexing terminology and definitions. The origins lie in the old DG approach which is used in this book. One prominent example is the use of the words "covariant" and "contravariant". Most modern authors think that these words are defined as exactly the opposite of what they should logically be. This is one of the great mysteries of DG terminology. Tullio Levi-Civita explains the usage of "covariant" and "contravariant" on pages 20, 67, 68, 71 and 144, and "invariance" (in the DG context) is explained on page 62. This helps to solve this ancient mystery!It is an interesting exercise to read through this book to try to recognise modern DG and tensor calculus concepts in the old-style context of differential equations within which Tullio Levi-Civita worked.* Chapter 1 (12 pages) presents the basic calculus of Jacobians and the implicit function theorem.* Chapter 2 (20 pages) is about integrability of first order systems of partial differential equations, bilinear covariants and Pfaffians.* Chapter 3 (28 pages) is about linear operators on real-valued functions on a manifold, including the Poisson bracket (which Levi-Civita called the "alternate function" or "Poisson parenthesis") and integration of linear operator fields (i.e. vector fields).* Chapter 4 (25 pages) contains a few pages on the physical interpretation of differentials and differential operators in terms of force fields. Then follows what we would now recognise as tensor calculus and tensor algebra, including terminology for m-fold covariant and contravariant tensors. Also discussed are tensor symmetry, tensor addition, multiplication, contraction and composition.* Chapter 5 (58 pages) deals with line elements on manifolds, quadratic forms for distance, transformation rules for tensors, absolute parallelism on developable surfaces, parallel transport of angles between vectors along geodesics, intrinsic parallelism, and Christoffel symbols. At this point, the concept of a "metric manifold", which we would call a "Riemannian manifold" nowadays, is introduced. Then geodesics and parallelism are defined on Riemannian manifolds in terms of Christoffel symbols.* Chapter 6 (28 pages) defines covariant differentiation and geodesic coordinates.* Chapter 7 (48 pages) defines "Riemann’s symbols", which we now call the Riemannian curvature. For these, Levi-Civita uses a notation very similar to the old-fashioned notation for Christoffel symbols. Various symmetry properties of the Riemann curvature tensor are demonstrated, including the Bianchi identities. Then the relation of the Riemannian curvature to parallel displacement around an infinitesimal parallelogram, the Ricci curvature tensor (here called

"Ricci's symbols"), the Einstein tensor, the equations of geodesic variation, and Jacobi fields are presented.* Chapter 8 (22 pages) presents transformation rules for Christoffel symbols, covariant differentiation and the Riemann curvature tensor, plus manifolds of constant curvature.* Chapter 9 (19 pages) deals with immersability in Euclidean spaces, manifolds of constant curvature, and hyperspheres.* Chapter 10 (26 pages) returns to intrinsic geometry. But I don't quite understand what this chapter is about. It looks like something I saw in a book by Gaston Darboux in the 19th century.* Chapter 11 (82 pages) gets into physics, like Hamiltonian mechanics, relativistic Lagrangian mechanics, Einstein's special relativity, rigid body kinetics, Lorentz transformations, geometrical optics, and the stress-energy tensor.* Chapter 12 (72 pages) presents Einstein's gravity equations, derivation of the precession of the perihelion of Mercury, the Schwarzschild singularity solution for the GR equations, the De Sitter universe, and Einstein's cosmological constant on the last 3 pages.In the last 3 pages, the cosmological constant is denoted as Î» rather than the modern Î›. It is interesting to see how this was justified in the days before we realised that the universe is expanding. Also interesting is Levi-Civita's proof on the last page that the radius of the universe is "certainly considerably greater than ... 10,000 light-years". He was certainly right about that!Throughout the book, the tedious old notations for multiple functions of multiple variables are used instead of the modern notations for vectors, tensors and matrices.All in all, this is not a book for the modern student to learn differential geometry or general relativity. But it is a valuable record of a stage in the historical development of these subjects. Levi-Civita is generally recognised as one of the most important early founders of differential geometry, along with GauÃ , Riemann, Christoffel and Ricci-Curbastro.

Although it is a bit dated, this is a wonderful book by the one of the main instigators of Tensor Calculus. I would like to stress however as others have noted that it is quite difficult material, but that is the case with most forms of upper division mathematics. The coverage of Classical mechanics is a bit sparse and nothing of electrodynamics is considered since the author himself states that there is much material that already exploits the usage of Tensor analysis in electromagnetism. Nevertheless the treatment of General Relativity is quite complete. For those interested in Tensors, this is one of the main books to have. Those with knowledge of Multivariate calculus and linear algebra should be able to fly through the introductory chapters. After this book, I suggest Eisenhart and Einstein's paper on the General theory as ways to venture the wonderful world of tensors.Interestingly enough I have also heard that Tensors are being superseded by "functors." But, as is the case of physics and mathematics, one cannot plunge into the abyss of contemporary knowledge without some notions from the past.

This is the tough math you would like to have mastered in college. I am slowly working through this to try to stretch myself. It is slow going and demands a lot from the reader -- at least for me.

This book constitutes the history of Absolute Differential Calculus, born from the cooperation from Albert Einstein and Tullio Levi Civita. It also keeps an account on what Gregorio Ricci Curbastro had previously estabilished on Tensors. I think it’s a wonderful occasion, to study from the original papers of the authors of a theory, though they are generally somehow obscure, with respect to textbooks. This is definitely a great book.

The challenge of my mind is here.

Not quite a page-turner, but this book presents good applications of tensor math. Sometimes difficult to follow, the book omits many "assumed" steps. However, a fine escape into the world of absolute differential calculus.

A must have for all physics majors. Excellent outside source for mechanics, especially upper-division.

The book was absolutely perfect. The shipment was very late. I ordered it on june 3rd and I received it on july 6th. The expected delivery date was june20-25 . It was not possible to track the shipment.

to Differential Equations and Their Applications (Dover Books on Mathematics) Tensor and Vector Analysis: With Applications to Differential Geometry (Dover Books on Mathematics) Cohomology and Differential Forms (Dover Books on Mathematics) Hilbert Space Methods in Partial Differential Equations (Dover Books on Mathematics) Partial Differential Equations of Mathematical Physics and Integral Equations (Dover Books on Mathematics) Differential Equations and Their Applications: An Introduction to Applied Mathematics (Texts in Applied Mathematics) (v. 11) Drawing for the Absolute Beginner: A Clear & Easy Guide to Successful Drawing (Art for the Absolute Beginner) Drawing Nature for the Absolute Beginner: A Clear & Easy Guide to Drawing Landscapes & Nature (Art for the Absolute Beginner) Drawing Portraits for the Absolute Beginner: A Clear & Easy Guide to Successful Portrait Drawing (Art for the Absolute Beginner) Oil Painting For The Absolute Beginner: A Clear & Easy Guide to Successful Oil Painting (Art for the Absolute Beginner) Keyboard for the Absolute Beginner: Absolutely Everything You Need to Know to Start Playing Now!, Book & CD (Absolute Beginner Series)