Differential Forms And The Geometry Of General Relativity

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Birkhäuser This book explains and helps readers to develop geometric intuition as it relates to differential forms. It includes over 250 figures to aid understanding and enable readers to visualize the concepts being discussed. The author gradually builds up to the basic ideas and concepts so that definitions, when made, do not appear out of nowhere, and both the importance and role that theorems play is evident as or before they are presented. With a clear writing style and easy-to-understand motivations for each topic, this book is primarily aimed at second- or third-year undergraduate math and physics students with a basic knowledge of vector calculus and linear algebra.

Differential Forms

Cambridge University Press

This monograph explores the cohomological theory of manifolds with various sheaves and its application to differential geometry. Based on lectures given by author Izu Vaisman at Romania's University of Iasi, the treatment is suitable for advanced undergraduates and graduate students of mathematics as well as mathematical researchers in differential geometry, global analysis, and topology. A self-contained development of cohomological theory constitutes the central part of the book. Topics include categories and functors, the Čech cohomology with coefficients in sheaves, the theory of fiber bundles, and differentiable, foliated, and complex analytic manifolds. The final chapter covers the theorems of de Rham and Dolbeault-Serre and examines the theorem of Allendoerfer and Eells, with applications of these theorems to characteristic classes and the general theory of harmonic forms.

Topics in Differential Geometry

Springer Since the times of Gauss, Riemann, and Poincare, one of the principal goals of the study of manifolds has been to relate local analytic properties of a manifold with its global topological properties. Among the high points on this route are the Gauss-Bonnet formula, the de Rham complex, and the Hodge theorem; these results show, in particular, that the central tool in reaching the main goal of global analysis is the theory of differential forms. This book is a comprehensiv e introduction to differential forms. It begins with a quick presentation of the notion of differentiable manifolds and then develops basic properties of differential forms as well as fundamental results about them, such as the de Rham and Frobenius theorems.The second half of the book is devoted to more advanced material, including Laplacians and harmonic forms on manifolds, the concepts of vector bundles and fiber bundles, and the theory of characteristic classes. Among the less traditional topics treated in the book is a detailed description of the Chern-Weil theory. With minimal prerequisites, the book can serve as a textbook for an advanced undergraduate or a graduate course in differential geometry. *Manifolds and Differential Geometry* Springer Science & Business Media Differential Forms and the Geometry of General Relativity provides readers with a coherent path to understanding relativity. Requiring little more than calculus and some linear algebra, it helps readers learn just enough differential geometry to grasp the basics of general relativity. The book contains two intertwined but distinct halves. Designed for advanced undergraduate or beginning graduate students in mathematics or physics, most of the text requires little more than familiarity with calculus and linear algebra. The first half presents an introduction to general relativity that describes some of the surprising implications of relativity without introducing more formalism than necessary. This nonstandard approach uses differential forms rather than tensor calculus and minimizes the use of "index gymnastics" as much as possible. The second half of the book takes a more detailed look at the mathematics of differential forms. It covers the theory behind the mathematics used in the first half by emphasizing a conceptual understanding instead of formal proofs. The book provides a language to describe curvature, the key geometric idea in general relativity.

Tensors, Differential Forms, and Variational Principles

Springer

This book lets readers understand differential geometry with differential forms. It is unique in providing detailed treatments of topics not normally found elsewhere, like the programs of B. Riemann and F. Klein in the second half of the 19th century, and their being superseded by E. Cartan in the twentieth. Several conservation laws are presented in a unified way. The Einstein 3-form rather

than the Einstein tensor is emphasized; their relationship is shown. Examples are chosen for their pedagogic value. Numerous advanced comments are sprinkled throughout the text. The equations of structure are addressed in different ways. First, in affine and Euclidean spaces, where torsion and curvature simply happen to be zero. In a second approach, the 2-torus and the punctured plane and 2-sphere are endowed with the "Columbus connection," torsion becoming a concept which could have been understood even by sailors of the 15th century. Those equations are then presented as the breaking of integrability conditions for connection equations. Finally, a topological definition brings together the concepts of connection and equations of structure. These options should meet the needs and learning objectives of readers with very different backgrounds.
Dr Howard E Brandt

Differential Geometry

John Wiley & Sons

This book explains and helps readers to develop geometric intuition as it relates to differential forms. It includes over 250 figures to aid understanding and enable readers to visualize the concepts being discussed. The author gradually builds up to the basic ideas and concepts so that definitions, when made, do not appear out of nowhere, and both the importance and role that theorems play is evident as or before they are presented. With a clear writing style and easy-to-understand motivations for each topic, this book is primarily aimed at second- or third-year undergraduate math and physics students with a basic knowledge of vector calculus and linear algebra.

A Visual Introduction to Differential Forms and Calculus on Manifolds

Springer Science & Business Media

An introduction to differential geometry with applications to mechanics and physics. It covers topology and differential calculus in banach spaces; differentiable manifold and mapping submanifolds; tangent vector space; tangent bundle, vector field on manifold, Lie algebra structure, and one-parameter group of diffeomorphisms; exterior differential forms; Lie derivative and Lie algebra; n-form integration on n-manifold; Riemann geometry; and more. It includes 133 solved exercises.

Differential Forms and Applications Cambridge University Press Developed from a first-year graduate course in algebraic topology, this text is an informal introduction to some of the main ideas of contemporary homotopy and cohomology theory. The materials are structured around four core areas: de Rham theory, the Cech-de Rham complex, spectral sequences, and characteristic classes. By using the de Rham theory of differential forms as a prototype of cohomology, the machineries of algebraic topology are made easier to assimilate. With its stress on concreteness, motivation, and readability, this book is equally suitable for self-study and as a one-semester course in topology.

Second Edition Cambridge University Press This text presents a graduate-level introduction to differential geometry for mathematics and physics students. The exposition follows the historical development of the concepts of connection and curvature with the goal of explaining the Chern–Weil theory of characteristic classes on a principal bundle. Along the way we encounter some of the high points in the history of differential geometry, for example, Gauss' Theorema Egregium and the Gauss–Bonnet theorem. Exercises throughout the book test the reader’s understanding of the material and sometimes illustrate extensions of the theory. Initially, the prerequisites for the reader include a passing familiarity with manifolds. After the first chapter, it becomes necessary to understand and manipulate differential forms. A knowledge of de Rham cohomology is required for the last third of the text. Prerequisite material is contained in author's text An Introduction to Manifolds, and can be learned in one semester. For the benefit of the reader and to establish common notations, Appendix A recalls the basics of manifold theory. Additionally, in an attempt to make the exposition more self-contained, sections on algebraic constructions such as the tensor product and the exterior power are included. Differential geometry, as its name implies, is the study of geometry using differential calculus. It dates back to Newton and Leibniz in the seventeenth century, but it was not until the nineteenth century, with the work of

Gauss on surfaces and Riemann on the curvature tensor, that differential geometry flourished and its modern foundation was laid. Over the past one hundred years, differential geometry has proven indispensable to an understanding of the physical world, in Einstein's general theory of relativity, in the theory of gravitation, in gauge theory, and now in string theory. Differential geometry is also useful in topology, several complex variables, algebraic geometry, complex manifolds, and dynamical systems, among other fields. The field has even found applications to group theory as in Gromov's work and to probability theory as in Diaconis's work. It is not too far-fetched to argue that differential geometry should be in every mathematician's arsenal.

A New Approach to Differential Geometry using Clifford's Geometric Algebra CRC Press

Introduces the use of exterior differential forms as a powerful took in the analysis of a variety of mathematical problems in the physical and engineering sciences.

Differential Forms with Applications to the Physical Sciences Springer Science & Business Media

Differential geometry arguably offers the smoothest transition from the standard university mathematics sequence of the first four semesters in calculus, linear algebra, and differential equations to the higher levels of abstraction and proof encountered at the upper division by mathematics majors. Today it is possible to describe differential geometry as "the study of structures on the tangent space," and this text develops this point of view. This book, unlike other introductory texts in differential geometry, develops the architecture necessary to introduce symplectic and contact geometry alongside its Riemannian cousin. The main goal of this book is to bring the undergraduate student who already has a solid foundation in the standard mathematics curriculum into contact with the beauty of higher mathematics. In particular, the presentation here emphasizes the consequences of a definition and the careful use of examples and constructions in order to explore those consequences.

Differential Forms in Algebraic Topology

World Scientific Publishing Company

This monograph is the first one to

systematically present a series of local and global estimates and inequalities for differential forms, in particular the ones that satisfy the A-harmonic equations. The presentation focuses on the Hardy-Littlewood, Poincare, Cacciooli, imbedded and reverse Holder inequalities. Integral estimates for operators, such as homotopy operator, the Laplace-Beltrami operator, and the gradient operator are discussed next. Additionally, some related topics such as BMO inequalities, Lipschitz classes, Orlicz spaces and inequalities in Carnot groups are discussed in the concluding chapter. An abundance of bibliographical references and historical material supplement the text throughout. This rigorous presentation requires a familiarity with topics such as differential forms, topology and Sobolev space theory. It will serve as an invaluable reference for researchers, instructors and graduate students in analysis and partial differential equations and could be used as additional material for specific courses in these fields.
Global Analysis Courier Corporation Differential forms are a powerful mathematical technique to help students, researchers,

and engineers solve problems in geometry and analysis, and their applications. They both unify and simplify results in concrete settings, and allow them to be clearly and effectively generalized to more abstract settings. Differential Forms has gained high recognition in the mathematical and scientific community as a powerful computational tool in solving research problems and simplifying very abstract problems. Differential Forms, 2nd Edition, is a solid resource for students and professionals needing a general understanding of the mathematical theory and to be able to apply that theory into practice. Provides a solid theoretical basis of how to develop and apply differential forms to real research problems Includes computational methods to enable the reader to effectively use differential forms Introduces theoretical concepts in an accessible manner

Riemannian, Contact, Symplectic

Springer Science & Business Media

An early tract for students of differential geometry and mathematical physics.

Problems and Solutions in Differential Geometry, Lie Series, Differential Forms, Relativity and

Applications Abramis There already exist a number of excellent graduate textbooks on the theory of differential forms as well as a handful of very good undergraduate textbooks on multivariable calculus in which this subject is briefly touched upon but not elaborated on enough.The goal of this textbook is to be readable and usable for undergraduates. It is entirely devoted to the subject of differential forms and explores a lot of its important ramifications.In particular, our book provides a detailed and lucid account of a fundamental result in the theory of differential forms which is, as a rule, not touched upon in undergraduate texts: the isomorphism between the Čech cohomology groups of a differential manifold and its de Rham cohomology groups.
Invariants of Quadratic Differential Forms Courier Dover Publications
Incisive, self-contained account of tensor analysis and the calculus of exterior differential forms, interaction between the concept of invariance and the calculus of variations. Emphasis is on analytical techniques. Includes problems.
Differential Geometry and Mathematical Physics Springer

Science & Business Media
This book introduces the reader to the world of differential forms and their uses in geometry, analysis, and mathematical physics. It begins with a few basic topics, partly as review, then moves on to vector analysis on manifolds and the study of curves and surfaces in 3-space. Lie groups and homogeneous spaces are discussed, providing the appropriate framework for introducing symmetry in both mathematical and physical contexts. The final third of the book applies the mathematical ideas to important areas of physics: Hamiltonian mechanics, statistical mechanics, and electrodynamics. There are many classroom-tested exercises and examples with excellent figures throughout. The book is ideal as a text for a first course in differential geometry, suitable for advanced undergraduates or graduate students in mathematics or physics.

A New Approach to Differential Geometry using Clifford's Geometric Algebra

Courier Corporation
An inviting, intuitive, and visual exploration of differential geometry and forms Visual Differential Geometry and Forms fulfills two principal

goals. In the first four acts, Tristan Needham puts the geometry back into differential geometry. Using 235 hand-drawn diagrams, Needham deploys Newton's geometrical methods to provide geometrical explanations of the classical results. In the fifth act, he offers the first undergraduate introduction to differential forms that treats advanced topics in an intuitive and geometrical manner. Unique features of the first four acts include: four distinct geometrical proofs of the fundamentally important Global Gauss-Bonnet theorem, providing a stunning link between local geometry and global topology; a simple, geometrical proof of Gauss's famous Theorema Egregium; a complete geometrical treatment of the Riemann curvature tensor of an n-manifold; and a detailed geometrical treatment of Einstein's field equation, describing gravity as curved spacetime (General Relativity), together with its implications for gravitational waves, black holes, and cosmology. The final act elucidates such topics as the unification of all the integral theorems of vector calculus; the elegant reformulation of Maxwell's equations of electromagnetism in terms of 2-forms; de Rham cohomology; differential geometry via Cartan's method of moving frames; and the calculation of the Riemann tensor using curvature 2-forms. Six of the seven chapters of Act V can be read completely independently from the rest of the book. Requiring only basic calculus and geometry, Visual Differential Geometry and Forms provocatively rethinks the way this important area of mathematics should be considered and taught. Springer Science & Business Media Introduction to Differential Geometry with applications to Navier-Stokes Dynamics is an invaluable manuscript for anyone who wants to understand and use exterior calculus and differential geometry, the modern approach to calculus and geometry. Author Troy Story makes use of over thirty years of research experience to provide a smooth transition from conventional calculus to exterior calculus and differential geometry, assuming only a knowledge of conventional calculus. Introduction to Differential Geometry with applications to Navier-Stokes Dynamics includes the topics: Geometry, Exterior calculus, Homology and co-homology, Applications of differential geometry and exterior calculus to: Hamiltonian mechanics, geometric optics, irreversible thermodynamics, black hole dynamics, electromagnetism, classical string fields, and Navier-Stokes dynamics. A Geometric Approach to Differential Forms American Mathematical Soc. This is a self-contained introductory textbook on the calculus of differential forms and modern differential geometry. The intended audience is physicists, so the author emphasises applications and geometrical reasoning in order to give results and concepts a precise but intuitive meaning without getting bogged down in analysis. The large number of diagrams helps elucidate the fundamental ideas. Mathematical topics covered include differentiable manifolds, differential forms and twisted forms, the Hodge star operator, exterior differential systems and symplectic geometry. All of the mathematics is motivated and illustrated by useful physical examples.