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Sage for Undergraduates - Gregory V. Bard 2022-09-26
As the open-source and free alternative to expensive software like Maple™, Mathematica®, and MATLAB®, Sage offers anyone with a web browser the ability to

use cutting-edge mathematical software and share the results with others, often with stunning graphics. This book is a gentle introduction to Sage for undergraduate students during Calculus II, Multivariate Calculus, Differential Equations, Linear Algebra, Math Modeling, or Operations Research. This book assumes no background in programming, but the reader who finishes the book will have learned about 60 percent of a first semester computer science course, including much of the Python programming language. The audience is not only math majors, but also physics, engineering, environmental science, finance, chemistry, economics, data science, and computer science majors. Many of the book's examples are drawn from those fields. Filled with “challenges” for the students to test their progress, the book is also ideal for self-study. What's New in the Second Edition: In 2019, Sage transitioned from Python 2 to Python 3, which changed the syntax in several significant ways, including for the print command. All the examples in this book have been rewritten to be compatible with Python 3. Moreover, every code block longer than four lines has been placed in an archive on the book's website http://www.sage-for-undergraduates.org that is maintained by the author, so that the students won't have to retype the code! Other additions include… The number of “challenges” for the students to test their own progress in learning Sage has roughly doubled, which will be a great boon for self-study.There's approximately 150 pages of new content, including: New projects on Leontief Input-Output Analysis and on Environmental ScienceNew sections on Complex Numbers and Complex Analysis, on SageTex, and on solving problems via Monte-Carlo Simulations.The first three sections of Chapter 1 have been completely rewritten to give absolute beginners a smoother transition into Sage.

Introduction to Differential Topology - T. Bröcker 1982-09-16

This book is intended as an elementary introduction to differential manifolds. The authors concentrate on the intuitive geometric aspects and explain not only the basic properties but also teach how to do the basic geometrical constructions. An integral part of the work are the many diagrams which illustrate the proofs. The text is liberally supplied with exercises and will be welcomed by students with some basic knowledge of analysis and topology.

Manifolds, Tensors and Forms - Paul Renteln 2014

Comprehensive treatment of the essentials of modern differential geometry and topology for graduate students in mathematics and the physical sciences.

Geometry of Characteristic Classes - Shigeyuki Morita 2001

Characteristic classes are central to the modern study of the topology and geometry of manifolds. They were first introduced in topology, where, for instance, they could be used to define obstructions to the existence of certain fiber bundles.

Characteristic classes were later defined (via the Chern-Weil theory) using connections on vector bundles, thus revealing their geometric side. In the late 1960s new theories arose that described still finer structures. Examples of the so-called secondary characteristic classes came from Chern-Simons invariants, Gelfand-Fuks cohomology, and the characteristic classes of flat bundles. The new techniques are particularly useful for the study of fiber bundles whose structure groups are not finite dimensional. The theory of characteristic classes of surface bundles is perhaps the most developed. Here the special geometry of surfaces allows one to connect this theory to the theory of moduli space of Riemann surfaces, i.e., Teichmüller theory. In this book Morita presents an introduction to the modern theories of characteristic classes.

Differential Forms - Steven H. Weintraub 1997

This text is one of the first to treat vector calculus using differential forms in place of vector fields and other outdated techniques. Geared towards students taking courses in multivariable calculus, this innovative book aims to make the subject more readily understandable. Differential forms unify and simplify the subject of multivariable calculus, and students who learn the subject as it is presented in this book should come away with a better conceptual understanding of it than those who learn using conventional methods. * Treats vector calculus using differential forms

* Presents a very concrete introduction to differential forms * Develops Stokess theorem in an easily understandable way * Gives well-supported, carefully stated, and thoroughly explained definitions and theorems. * Provides glimpses of further topics to entice the interested student

Geometry of Differential Forms - Shigeyuki Morita 2001

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. The book by Morita is a comprehensive introduction to differential forms. It begins with a quick introduction to the notion of differentiable manifolds and then develops basic properties of differential forms as well as fundamental results concerning 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 is a detailed description of the Chern-Weil theory. The book can serve as a textbook for

undergraduate students and for graduate students in geometry.
Differential Geometry - Loring W. Tu 2017-06-01
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.

Differential and Riemannian Manifolds - Serge Lang 2012-12-06 This is the third version of a book on differential manifolds. The first version appeared in 1962, and was written at the very beginning of a period of great expansion of the subject. At the time, I found no satisfactory book for the foundations of the subject, for multiple reasons. I expanded the book in 1971, and I expand it still further today. Specifically, I have added three chapters on Riemannian and pseudo Riemannian geometry, that is, covariant derivatives, curvature, and some applications up to the Hopf-Rinow and

Hadamard-Cartan theorems, as well as some calculus of variations and applications to volume forms. I have rewritten the sections on sprays, and I have given more examples of the use of Stokes' theorem. I have also given many more references to the literature, all of this to broaden the perspective of the book, which I hope can be used among things for a general course leading into many directions. The present book still meets the old needs, but fulfills new ones. At the most basic level, the book gives an introduction to the basic concepts which are used in differential topology, differential geometry, and differential equations. In differential topology, one studies for instance homotopy classes of maps and the possibility of finding suitable differentiable maps in them (immersions, embeddings, isomorphisms, etc.).

Smooth Manifolds and Observables - Jet Nestruev 2020-09-10

This book gives an introduction to fiber spaces and differential operators on smooth manifolds. Over the last 20 years, the authors developed an algebraic approach to the subject and they explain in this book why differential calculus on manifolds can be considered as an aspect of commutative algebra. This new approach is based on the fundamental notion of observable which is used by physicists and will further the understanding of the mathematics underlying quantum field theory.

Geometry, Topology and Physics - Mikio Nakahara 2018-10-03

Differential geometry

and topology have become essential tools for many theoretical physicists. In particular, they are indispensable in theoretical studies of condensed matter physics, gravity, and particle physics. Geometry, Topology and Physics, Second Edition introduces the ideas and techniques of differential geometry and topology at a level suitable for postgraduate students and researchers in these fields. The second edition of this popular and established text incorporates a number of changes designed to meet the needs of the reader and reflect the development of the subject. The book features a considerably expanded first chapter, reviewing aspects of path integral quantization and gauge theories. Chapter 2 introduces the mathematical concepts of maps, vector spaces, and topology. The following chapters focus on more elaborate concepts in geometry and topology and discuss the application of these concepts to liquid crystals, superfluid helium, general relativity, and bosonic string theory. Later chapters unify geometry and topology, exploring fiber bundles, characteristic classes, and index theorems. New to this second edition is the proof of the index theorem in terms of supersymmetric quantum mechanics. The final two chapters are devoted to the most fascinating applications of geometry and topology in contemporary physics, namely the study of anomalies in gauge field theories and the analysis of Polakov's bosonic string theory from the geometrical point of view. Geometry, Topology and Physics, Second Edition is an ideal introduction to differential geometry and topology for postgraduate students and researchers in theoretical and mathematical physics.

Lectures on Symplectic Geometry - Ana Cannas da Silva 2004-10-27

The goal of these notes is to provide a fast introduction to symplectic geometry for graduate students with some knowledge of differential geometry, de Rham theory and classical Lie groups. This text addresses symplectomorphisms, local forms, contact manifolds, compatible almost complex structures, Kaehler manifolds, hamiltonian mechanics, moment maps, symplectic reduction and symplectic toric manifolds. It contains guided problems, called homework, designed to complement the exposition or extend the reader's understanding. There are by now excellent references on symplectic geometry, a subset of which is in the bibliography of this book. However, the most efficient introduction to a subject is often a short elementary treatment, and these notes attempt to serve that purpose. This text provides a taste of areas of current research and will prepare the reader to explore recent papers and extensive books on symplectic geometry where the pace is much faster. For this reprint numerous corrections and clarifications have been made, and the layout has been improved.

An Introduction to Differential Manifolds - Jacques Lafontaine 2015-07-29

This book is an

introduction to differential manifolds. It gives solid preliminaries for more advanced topics: Riemannian manifolds, differential topology, Lie theory. It presupposes little background: the reader is only expected to master basic differential calculus, and a little point-set topology. The book covers the main topics of differential geometry: manifolds, tangent space, vector fields, differential forms, Lie groups, and a few more sophisticated topics such as de Rham cohomology, degree theory and the Gauss-Bonnet theorem for surfaces. Its ambition is to give solid foundations. In particular, the introduction of “abstract” notions such as manifolds or differential forms is motivated via questions and examples from mathematics or theoretical physics. More than 150 exercises, some of them easy and classical, some others more sophisticated, will help the beginner as well as the more expert reader. Solutions are provided for most of them. The book should be of interest to various readers: undergraduate and graduate students for a first contact to differential manifolds, mathematicians from other fields and physicists who wish to acquire some feeling about this beautiful theory. The original French text Introduction aux variétés différentielles has been a best-seller in its category in France for many years. Jacques Lafontaine was successively assistant Professor at Paris Diderot University and

Professor at the University of Montpellier, where he is presently emeritus. His main research interests are Riemannian and pseudo-Riemannian geometry, including some aspects of mathematical relativity. Besides his personal research articles, he was involved in several textbooks and research monographs.

Algebraic Topology - William Fulton 2013-12-01

To the Teacher. This book is designed to introduce a student to some of the important ideas of algebraic topology by emphasizing the re lations of these ideas with other areas of mathematics. Rather than choosing one point of view of modem topology (homotopy theory, simplicial complexes, singular theory, axiomatic homology, differ ential topology, etc.), we concentrate our attention on concrete prob lems in low dimensions, introducing only as much algebraic machin ery as necessary for the problems we meet. This makes it possible to see a wider variety of important features of the subject than is usual in a beginning text. The book is designed for students of mathematics or science who are not aiming to become practicing algebraic topol ogists-without, we hope, discouraging budding topologists. We also feel that this approach is in better harmony with the historical devel opment of the subject. What would we like a student to know after a first course in to pology (assuming we reject the answer: half of what one would like the student to know after a second course in topology)? Our answers to this have guided the choice of material, which includes: under standing the relation between homology and integration, first on plane domains, later on Riemann surfaces and in higher dimensions; wind ing numbers and degrees of mappings, fixed-point theorems; appli cations such as the Jordan curve theorem, invariance of domain; in dices of vector fields and Euler characteristics; fundamental groups

Connections, Curvature, and Cohomology V1 - 1972-07-31
Connections, Curvature, and Cohomology V1

Topology and Condensed Matter Physics - Somendra Mohan Bhattacharjee 2017-12-20
This book introduces aspects of topology and applications to problems in condensed matter physics. Basic topics in mathematics have been introduced in a form accessible to physicists, and the use of topology in quantum, statistical and solid state physics has been developed with an emphasis on pedagogy. The aim is to bridge the language barrier between physics and mathematics, as well as the different specializations in physics. Pitched at the level of a graduate student of physics, this book does not assume any additional knowledge of mathematics or physics. It is therefore suited for advanced postgraduate students as well. A collection of selected problems will help the reader learn the topics on one's own, and the broad range of topics covered will make the text a valuable resource for practising researchers in the field. The book consists of two parts: one

corresponds to developing the necessary mathematics and the other discusses applications to physical problems. The section on mathematics is a quick, but more-or-less complete, review of topology. The focus is on explaining fundamental concepts rather than dwelling on details of proofs while retaining the mathematical flavour. There is an overview chapter at the beginning and a recapitulation chapter on group theory. The physics section starts with an introduction and then goes on to topics in quantum mechanics, statistical mechanics of polymers, knots, and vertex models, solid state physics, exotic excitations such as Dirac quasiparticles, Majorana modes, Abelian and non-Abelian anyons. Quantum spin liquids and quantum information-processing are also covered in some detail.

Lecture Notes on Motivic Cohomology - Carlo Mazza 2006

The notion of a motive is an elusive one, like its namesake "the motif" of Cezanne's impressionist method of painting. Its existence was first suggested by Grothendieck in 1964 as the underlying structure behind the myriad cohomology theories in Algebraic Geometry. We now know that there is a triangulated theory of motives, discovered by Vladimir Voevodsky, which suffices for the development of a satisfactory Motivic Cohomology theory. However, the existence of motives themselves remains conjectural. This book provides an account of the triangulated theory of motives. Its purpose is to introduce Motivic

Cohomology, to develop its main properties, and finally to relate it to other known invariants of algebraic varieties and rings such as Milnor K-theory, etale cohomology, and Chow groups. The book is divided into lectures, grouped in six parts. The first part presents the definition of Motivic Cohomology, based upon the notion of presheaves with transfers. Some elementary comparison theorems are given in this part. The theory of (etale, Nisnevich, and Zariski) sheaves with transfers is developed in parts two, three, and six, respectively. The theoretical core of the book is the fourth part, presenting the triangulated category of motives. Finally, the comparison with higher Chow groups is developed in part five. The lecture notes format is designed for the book to be read by an advanced graduate student or an expert in a related field. The lectures roughly correspond to one-hour lectures given by Voevodsky during the course he gave at the Institute for Advanced Study in Princeton on this subject in 1999-2000. In addition, many of the original proofs have been simplified and improved so that this book will also be a useful tool for research mathematicians. Information for our distributors: Titles in this series are copublished with the Clay Mathematics Institute (Cambridge, MA).

Homology, Cohomology, And Sheaf Cohomology For Algebraic Topology, Algebraic Geometry, And Differential Geometry - Jean H Gallier 2022-01-19

For more than thirty years the senior author has been trying to learn algebraic geometry. In the process he discovered that many of the classic textbooks in algebraic geometry require substantial knowledge of cohomology, homological algebra, and sheaf theory. In an attempt to demystify these abstract concepts and facilitate understanding for a new generation of mathematicians, he along with co-author wrote this book for an audience who is familiar with basic concepts of linear and abstract algebra, but who never has had any exposure to the algebraic geometry or homological algebra. As such this book consists of two parts. The first part gives a crash-course on the homological and cohomological aspects of algebraic topology, with a bias in favor of cohomology. The second part is devoted to presheaves, sheaves, Cech cohomology, derived functors, sheaf cohomology, and spectral sequences. All important concepts are intuitively motivated and the associated proofs of the quintessential theorems are presented in detail rarely found in the standard texts.

Differentiable Manifolds - Lawrence Conlon 2013-04-17

This book is based on the full year Ph.D. qualifying course on differentiable manifolds, global calculus, differential geometry, and related topics, given by the author at Washington University several times over a twenty year period. It is addressed primarily to second year graduate students and well prepared first year students. Presupposed is a good grounding in general topology and modern algebra, especially linear algebra and the analogous theory of modules over a commutative, unitary ring. Although billed as a "first course" , the book is not intended to be an overly sketchy introduction. Mastery of this material should prepare the student for advanced topics courses and seminars in differen tial topology and geometry. There are certain basic themes of which the reader should be aware. The first concerns the role of differentiation as a process of linear approximation of non linear problems. The well understood methods of linear algebra are then applied to the resulting linear problem and, where possible, the results are reinterpreted in terms of the original nonlinear problem. The process of solving differential equations (i. e., integration) is the reverse of differentiation. It reassembles an infinite array of linear approximations, result ing from differentiation, into the original nonlinear data. This is the principal tool for the reinterpretation of the linear algebra results referred to above.

Algebraic Topology Via Differential Geometry - M. Karoubi 1987

In this volume the authors seek to illustrate how methods of differential geometry find application in the study of the topology of differential manifolds. Prerequisites are few since the authors take pains to set out the theory of differential forms and the algebra required. The reader is introduced to De Rham cohomology, and explicit and detailed calculations are present as examples. Topics covered include Mayer-Vietoris exact sequences, relative cohomology, Pioncare duality and Lefschetz's theorem. This book will be suitable for graduate students taking courses in algebraic topology and in differential topology. Mathematicians studying relativity and mathematical physics will find this an invaluable introduction to the techniques of differential geometry.

An Introduction to Manifolds - Loring W. Tu 2010-10-05

Manifolds, the higher-dimensional analogs of smooth curves and surfaces, are fundamental objects in modern mathematics. Combining aspects of algebra, topology, and analysis, manifolds have also been applied to classical mechanics, general relativity, and quantum field theory. In this streamlined introduction to the subject, the theory of manifolds is presented with the aim of helping the reader achieve a rapid mastery of the essential topics. By the end of the book the reader should be able to compute, at least for simple spaces, one of the most basic topological invariants of a manifold, its de Rham cohomology. Along the way, the reader acquires the knowledge and skills necessary for further study of geometry and topology. The requisite point-set topology is included in an appendix of twenty pages; other appendices review facts from real analysis and linear algebra. Hints and solutions are provided to many of the exercises and problems. This work may be used as the text for a one-semester graduate or advanced undergraduate course, as well as by students engaged in self-study. Requiring only minimal undergraduate prerequisites, 'Introduction to Manifolds' is also an excellent foundation for Springer's GTM 82, 'Differential Forms in Algebraic Topology'.

Connections, Curvature, and Cohomology: Lie groups, principal bundles, and characteristic classes - Werner Hildbert Greub 1973

Volume 2.

Twenty-Four Hours of Local Cohomology - Srikanth B. Iyengar 2007

This book is aimed to provide an introduction to local cohomology which takes cognizance of the breadth of its interactions with other areas of mathematics. It covers topics such as the number of defining equations of algebraic sets, connectedness properties of algebraic sets, connections to sheaf cohomology and to de Rham cohomology, Grobner bases in the commutative setting as well as for D-modules, the Frobenius morphism and characteristic p methods, finiteness properties of local cohomology modules, semigroup rings and polyhedral geometry, and hypergeometric systems arising from semigroups. The book begins with basic notions in geometry, sheaf theory, and homological algebra leading to the definition and basic properties of local cohomology. Then it develops the theory in a number of different directions, and draws connections with topology, geometry, combinatorics, and algorithmic aspects of the subject.

Vector Analysis - Klaus Jänich 2013-03-09

This book presents modern vector analysis and carefully describes the classical notation and understanding of the theory. It covers all of the classical vector analysis in Euclidean space, as well as on manifolds, and goes on to introduce de Rham Cohomology, Hodge theory, elementary differential geometry, and basic duality. The material is accessible to readers and students with only calculus and linear algebra as prerequisites. A large number of illustrations, exercises, and tests with answers make this book an invaluable self-study source.

Differential Geometry and Topology - Keith Burns 2005-05-27

Accessible, concise, and self-contained, this book offers an outstanding introduction to three related subjects: differential geometry, differential topology, and dynamical systems. Topics of special interest addressed in the book include Brouwer's fixed point theorem, Morse Theory, and the geodesic flow. Smooth manifolds, Riemannian metrics, affine connections, the curvature tensor, differential forms, and integration on manifolds provide the foundation for many applications in dynamical systems and mechanics. The authors also discuss the Gauss-Bonnet theorem and its implications in non-Euclidean geometry models. The differential topology aspect of the book centers on classical, transversality theory, Sard's theorem, intersection theory, and fixed-point theorems.

The construction of the de Rham cohomology builds further arguments for the strong connection between the differential structure and the topological structure. It also furnishes some of the tools necessary for a complete understanding of the Morse theory. These discussions are followed by an introduction to the theory of hyperbolic systems, with emphasis on the quintessential role of the geodesic flow. The integration of geometric theory, topological theory, and concrete applications to dynamical systems set this book apart. With clean, clear prose and effective examples, the authors' intuitive approach creates a treatment that is comprehensible to relative beginners, yet rigorous enough for those with more background and experience in the field.

Noncommutative Geometry - Alain Connes 2003-12-15

Noncommutative Geometry is one of the most deep and vital research subjects of present-day Mathematics. Its development, mainly due to Alain Connes, is providing an increasing number of applications and deeper insights for instance in Foliations, K-Theory, Index Theory, Number Theory but also in Quantum Physics of elementary particles. The purpose of the Summer School in Martina Franca was to offer a fresh invitation to the subject and closely related topics; the contributions in this volume include the four main lectures, cover advanced developments and are delivered by prominent specialists.

Cohomology and Differential Forms - Izu

Vaisman 2016-07-28 Self-contained development of cohomological theory of manifolds with various sheaves and its application to differential geometry covers categories and functions, sheaves and cohomology, fiber and vector bundles, and cohomology classes and differential forms. 1973 edition.

Differential Topology - Victor Guillemin 2010 Differential Topology provides an elementary and intuitive introduction to the study of smooth manifolds. In the years since its first publication, Guillemin and Pollack's book has become a standard text on the subject. It is a jewel of mathematical exposition, judiciously picking exactly the right mixture of detail and generality to display the richness within. The text is mostly self-contained, requiring only undergraduate analysis and linear algebra. By relying on a unifying idea--transversality--the authors are able to avoid the use of big machinery or ad hoc techniques to establish the main results. In this way, they present intelligent treatments of important theorems, such as the Lefschetz fixed-point theorem, the Poincaré-Hopf index theorem, and Stokes theorem. The book has a wealth of exercises of various types. Some are routine explorations of the main material. In others, the students are guided step-by-step through proofs of fundamental results, such as the Jordan-Brouwer separation theorem. An exercise section in Chapter 4 leads the student through a construction of de Rham cohomology and a proof of its homotopy invariance. The book is suitable for either an introductory graduate course or an advanced undergraduate course.

Differential Forms - Guillemin Victor 2019-03-20

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.

Differential Forms in Algebraic Topology - Raoul Bott 2013-04-17

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.

Quantum Field Theory III: Gauge Theory - Eberhard Zeidler 2011-08-17

In this third volume of his modern introduction to quantum field theory, Eberhard Zeidler examines the mathematical and physical aspects of gauge theory as a principle tool for describing the four fundamental forces which act in the universe: gravitative, electromagnetic, weak interaction and strong interaction. Volume III concentrates on the classical aspects of gauge theory, describing the four fundamental forces by the curvature of appropriate fiber bundles. This must be supplemented by the crucial, but elusive quantization procedure. The book is arranged in four sections, devoted to realizing the universal principle force equals curvature: Part I: The Euclidean Manifold as a Paradigm Part II: Ariadne's Thread in Gauge Theory Part III: Einstein's Theory of Special Relativity Part IV: Ariadne's Thread in Cohomology For students of mathematics the book is designed to demonstrate that detailed knowledge of the physical background helps to reveal interesting interrelationships among diverse mathematical topics. Physics students will be exposed to a fairly advanced mathematics, beyond the level covered in the typical physics curriculum. Quantum Field Theory builds a bridge between mathematicians and physicists, based on challenging questions about the fundamental forces in the universe (macrocosmos), and in the world of elementary particles (microcosmos).

From Calculus to Cohomology - Ib H. Madsen 1997-03-13

An introductory textbook on cohomology and curvature with emphasis on applications.

Introduction to Hodge Theory - José Bertin 2002

Hodge theory originated as an application of harmonic theory to the study of the geometry of compact complex manifolds. The ideas have proved to be quite powerful, leading to fundamentally important results throughout algebraic geometry. This book consists of expositions of various aspects of modern Hodge theory. Its purpose is to provide the nonexpert reader with a precise idea of the current status of the subject. The three chapters develop distinct but closely related subjects:$L2$ Hodge theory and vanishing theorems; Frobenius and Hodge degeneration; variations of Hodge structures and mirror symmetry. The techniques employed cover a wide range of methods borrowed from the heart of mathematics: elliptic PDE theory, complex differential geometry, algebraic geometry incharacteristic p, cohomological and sheaf-theoretic methods, deformation theory of complex varieties, Calabi-Yau manifolds, singularity theory, etc. A special effort has been made to approach the various themes from their most na The reader should have some familiarity with differential and algebraic geometry, with other prerequisites varying by chapter. The book is suitable as an accompaniment to a second course in algebraic geometry.

Notes on Crystalline Cohomology. (MN-21) - Pierre Berthelot 2015-03-08

Written by Arthur Ogus on the basis of notes from Pierre Berthelot's seminar on crystalline cohomology at Princeton University in the spring of 1974, this book constitutes an informal introduction to a significant branch of algebraic geometry. Specifically, it provides the basic tools used in the study of crystalline cohomology of algebraic varieties in positive characteristic. Originally published in 1978. The Princeton Legacy Library uses the latest print-on-demand technology to again make available previously out-of-print books from the distinguished backlist of Princeton University Press. These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions. The goal of the Princeton Legacy Library is to vastly increase access to the rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905.

Foundations of Differentiable Manifolds and Lie Groups - Frank W. Warner 2013-11-11

Foundations of Differentiable Manifolds and Lie Groups gives a clear, detailed, and careful development of the basic facts on manifold theory and Lie Groups. Coverage includes differentiable manifolds, tensors and differentiable forms, Lie groups and homogenous spaces, and integration on manifolds. The book also provides a proof of the de Rham theorem via sheaf cohomology theory and develops the local theory of elliptic operators culminating in a proof of the Hodge theorem.

From Calculus to Cohomology - Ib Henning Madsen 1997

Differentiability in Banach Spaces, Differential Forms and Applications - Celso Melchiades Doria 2021-07-19

This book is divided into two parts, the first one to study the theory of differentiable functions between Banach spaces and the second to study the differential form formalism and to address the Stokes' Theorem and its applications. Related to the first part, there is an introduction to the content of Linear Bounded Operators in Banach Spaces with classic examples of compact and Fredholm operators, this aiming to define the derivative of Fréchet and to give examples in Variational Calculus and to extend the results to Fredholm maps. The Inverse Function Theorem is explained in full details to help the reader to understand the proof details and its motivations. The inverse function theorem and applications make up this first part. The text contains an elementary approach to Vector Fields and Flows, including the Frobenius Theorem. The Differential Forms are introduced and applied to obtain the Stokes Theorem and to define De Rham cohomology groups. As an application, the final chapter contains an introduction to the Harmonic Functions and a geometric approach to Maxwell's equations of electromagnetism.

Introduction to Smooth Manifolds - John M. Lee 2013-03-09

Author has written several excellent Springer books.; This book is a sequel to Introduction to Topological Manifolds; Careful and illuminating explanations, excellent diagrams and exemplary motivation; Includes short preliminary sections before each section explaining what is ahead and why

Finite Element Exterior Calculus - Douglas N. Arnold 2018-12-12

Computational methods to approximate the solution of differential equations play a crucial role in science, engineering, mathematics, and technology. The key processes that govern the physical world—wave propagation, thermodynamics, fluid flow, solid deformation, electricity and magnetism, quantum mechanics, general relativity, and many more—are described by differential equations. We depend on numerical methods for the ability to simulate, explore, predict, and control systems involving these processes. The finite element exterior calculus, or FEEC, is a powerful new theoretical approach to the design and understanding of numerical methods to solve partial differential equations (PDEs). The methods derived with FEEC preserve crucial geometric and topological structures underlying the equations and are among the most successful examples of structure-preserving methods in numerical PDEs. This volume aims to help numerical analysts master the fundamentals of FEEC, including the geometrical and functional analysis preliminaries, quickly and in one place. It is also accessible to mathematicians and students of mathematics from areas other than numerical analysis who are interested in understanding how techniques from geometry and topology play a role in numerical PDEs.

Visual Differential Geometry and Forms - Tristan Needham 2021-07-13

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.

Cartesian Currents in the Calculus of Variations I - Mariano Giaquinta 1998-08-19

This monograph (in two volumes) deals with non scalar variational problems arising in geometry, as harmonic mappings between Riemannian manifolds and minimal graphs, and in physics, as stable equilibrium configuations in nonlinear elasticity or for liquid crystals. The presentation is selfcontained and accessible to non specialists. Topics are treated as far as possible in an elementary way, illustrating results with simple examples; in principle, chapters and even sections are readable independently of the general context, so that parts can be easily used for graduate courses. Open questions are often mentioned and the final section of each chapter discusses references to the literature and sometimes supplementary results. Finally, a detailed Table of Contents and an extensive Index are of help to consult this monograph