Algebraic Topology Hatcher Solutions

Topology and GroupoidsAn Introduction to Morse TheoryAlgebraic TopologyA Concise Course in Algebraic TopologyAlgebraic Topology - Homotopy and HomologyAlgebraic TopologyIntroduction to TopologyAlgebraic TopologyLectures on the Topology of 3-ManifoldsLectures on Algebraic TopologyDifferential TopologyAlgebraic Topology of Finite Topological Spaces and ApplicationsAn Introduction to ManifoldsHomology TheoryGraph Theory and Its Applications, Second EditionLectures on Algebraic TopologyLecture Notes in Algebraic TopologyAlgebraic TopologyDifferential Forms in Algebraic TopologyA Basic Course in Algebraic TopologyIntroduction to Smooth ManifoldsAlgebraic TopologyAlgebraic TopologyK-TheoryHomotopical TopologyAn Introduction to Algebraic TopologyIntroduction to Topological ManifoldsElementary TopologyMatrix Groups for UndergraduatesPrinciples of TopologyClassical Topology and Combinatorial Group TheoryFoundations of Hyperbolic ManifoldsBasic Category TheoryAlgebraic TopologyA History of Algebraic and Differential Topology, 1900 - 1960Algebraic TopologyTopology and GeometryAlgebraic TopologyIntroduction to 3-ManifoldsCubical Homotopy Theory

Topology and Groupoids

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'.

An Introduction to Morse Theory

This introduction to some basic ideas in algebraic topology is devoted to the foundations and applications of homology theory. After the essentials of singular homology and some important applications are given, successive topics covered include attaching spaces, finite CW complexes, cohomology products, manifolds, Poincare duality, and fixed point theory.

This second edition includes a chapter on covering spaces and many new exercises.

Algebraic Topology

This text explains nontrivial applications of metric space topology to analysis. Covers metric space, point-set topology, and algebraic topology. Includes exercises, selected answers, and 51 illustrations. 1983 edition.

A Concise Course in Algebraic Topology

"A very valuable book. In little over 200 pages, it presents a well-organized and surprisingly comprehensive treatment of most of the basic material in differential topology, as far as is accessible without the methods of algebraic topology.There is an abundance of exercises, which supply many beautiful examples and much interesting additional information, and help the reader to become thoroughly familiar with the material of the main text." —MATHEMATICAL REVIEWS

Algebraic Topology - Homotopy and Homology

This book surveys the fundamental ideas of algebraic topology. The first part covers the fundamental group, its definition and application in the study of covering spaces. The second part turns to homology theory including cohomology, cup products, cohomology operations and topological manifolds. The final part is devoted to Homotropy theory, including basic facts about homotropy groups and applications to obstruction theory.

Algebraic Topology

From the Preface: K-theory was introduced by A. Grothendieck in his formulation of the Riemann- Roch theorem. For each projective algebraic variety, Grothendieck constructed a group from the category of coherent algebraic sheaves, and showed that it had many nice properties. Atiyah and Hirzebruch considered a topological analog defined for any compact space X, a group K{X) constructed from the category of vector bundles on X. It is this ''topological K-theory" that this book will study. Topological K-theory has become an important tool in topology. Using K- theory, Adams and Atiyah were able to give a simple proof that the only spheres which can be provided with H-space structures are S1, S3 and S7. Moreover, it is possible to derive a substantial part of stable homotopy theory from K-theory. The purpose of this book is to provide advanced students and mathematicians in other fields with the fundamental material in this subject. In addition, several applications of the type described above are included. In general we have tried to make this book self-contained, beginning with elementary concepts wherever possible; however, we assume that the reader is familiar with the basic definitions of homotopy theory: homotopy classes of maps and homotopy groups.Thus this book might be regarded as a fairly self-contained introduction to a "generalized cohomology theory".

Introduction to Topology

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.

Algebraic Topology

This textbook on elementary topology contains a detailed introduction to general topology and an introduction to algebraic topology via its most classical and elementary segment centered at the notions of fundamental group and covering space. The book is tailored for the reader who is determined to work actively. The proofs of theorems are separated from their formulations and are gathered at the end of each chapter. This makes the book look like a pure problem book and encourages the reader to think through each formulation. A reader who prefers a more traditional style can either find the proofs at the end of the chapter or skip them altogether. This style also caters to the expert who needs a handbook and prefers formulations not overshadowed by proofs. Most of the proofs are simple and easy to discover. The book can be useful and enjoyable for readers with quite different backgrounds and interests. The text is structured in such a way that it is easy to determine what to expect from each piece and how to use it. There is core material, which makes up a relatively small part of the book. The core material is interspersed with examples, illustrative and training problems, and relevant discussions. The reader who has mastered the core material acquires a strong background in elementary topology and will feel at home in the environment of abstract mathematics. With almost no prerequisites (except real numbers), the book can serve as a text for a course on general and beginning algebraic topology.

Lectures on the Topology of 3-Manifolds

Finite-dimensional Morse theory is easier to present fundamental ideas than in infinite-dimensional Morse theory, which is theoretically more involved. However, finite-dimensional Morse theory has its own significance. This volume explains the finte-dimensional Morse theory.

Lectures on Algebraic Topology

Already an international bestseller, with the release of this greatly enhanced second edition, Graph Theory and Its Applications is now an even better choice as a textbook for a variety of courses -- a textbook that will continue to serve your students as a reference for years to come. The superior explanations, broad coverage, and abundance of illustrations and exercises that positioned this as the premier graph theory text remain, but are now augmented by a broad range of improvements. Nearly 200 pages have been added for this edition, including nine new sections and hundreds of new exercises, mostly non-routine. What else is new? New chapters on measurement and analytic graph theory Supplementary exercises in each chapter - ideal for reinforcing, reviewing, and testing. Solutions and hints, often illustrated with figures, to selected exercises - nearly 50 pages worth Reorganization and extensive revisions in more than half of the existing chapters for smoother flow of the exposition Foreshadowing - the first three chapters now preview a number of concepts, mostly via the exercises, to pique the interest of reader Gross and Yellen take a comprehensive approach to graph theory that integrates careful exposition of classical developments with emerging methods, models, and practical needs. Their unparalleled treatment provides a text ideal for a two-semester course and a variety of one-semester classes, from an introductory one-semester course to courses slanted toward classical graph theory, operations research, data structures and algorithms, or algebra and topology.

Differential Topology

A short introduction ideal for students learning category theory for the first time.

Algebraic Topology of Finite Topological Spaces and Applications

This textbook is intended for a course in algebraic topology at the beginning graduate level. The main topics covered are the classification of compact 2-manifolds, the fundamental group, covering spaces, singular homology theory, and singular cohomology theory. These topics are developed systematically, avoiding all unnecessary definitions, terminology, and technical machinery. The text consists of material from the first five chapters of the author's earlier book, Algebraic Topology; an Introduction (GTM 56) together with almost all of his book, Singular Homology Theory (GTM 70). The material from the two earlier books has been substantially revised, corrected, and brought up to date.

An Introduction to Manifolds

This book is written as a textbook on algebraic topology. The first part covers the material for two introductory courses about homotopy and homology. The second part presents more advanced applications and concepts (duality, characteristic classes, homotopy groups of spheres, bordism). The author recommends starting an introductory course with homotopy theory. For this purpose, classical results are presented with new elementary proofs. Alternatively, one could start more traditionally with singular and axiomatic homology. Additional chapters are devoted to the geometry of manifolds, cell complexes and fibre bundles. A special feature is the rich supply of nearly 500 exercises and problems. Several sections include topics which have not appeared before in textbooks as well as simplified proofs for some important results. Prerequisites are standard point set topology (as recalled in the first chapter), elementary algebraic notions (modules, tensor product), and some terminology from category theory. The aim of the book is to introduce advanced undergraduate and graduate (master's) students to basic tools, concepts and results of algebraic topology. Sufficient background material from geometry and algebra is included.

Homology Theory

The amount of algebraic topology a graduate student specializing in topology must learn can be intimidating. Moreover, by their second year of graduate studies, students must make the transition from understanding simple proofs line-by-line to understanding the overall structure of proofs of difficult theorems. To help students make this transition, the material in this book is presented in an increasingly sophisticated manner. It is intended to bridge the gap between algebraic and geometric topology, both by providing the algebraic tools that a geometric topologist needs and by concentrating on those areas of algebraic topology that are geometrically motivated. Prerequisites for using this book include basic set-theoretic topology, the definition of CW-complexes, some knowledge of the fundamental group/covering space theory, and the construction of singular homology. Most of this material is briefly reviewed at the beginning of the book. The topics discussed by the authors include typical material for first- and second-year graduate courses. The core of the exposition consists of chapters on homotopy groups and on spectral sequences. There is also material that would interest students of geometric topology (homology with local coefficients and obstruction theory) and algebraic topology (spectra and generalized homology), as well as preparation for more advanced topics such as algebraic K-theory and the s-cobordism theorem. A unique feature of the book is the inclusion, at the end of each chapter, of several projects that require students to present proofs of substantial theorems and to write notes accompanying their explanations. Working on these projects allows students to grapple with the ``big picture'', teaches them how to give mathematical lectures, and prepares them for participating in research seminars. The book is designed as a textbook for graduate students studying algebraic and geometric topology and homotopy theory. It will also be useful for students from other fields such as differential geometry, algebraic geometry, and homological algebra. The exposition in the text is clear; special cases are presented over complex general statements.

Graph Theory and Its Applications, Second Edition

This textbook on algebraic topology updates a popular textbook from the golden era of the Moscow school of I. M. Gelfand. The first English translation, done many decades ago, remains very much in demand, although it has been long out-of-print and is difficult to obtain. Therefore, this updated English edition will be much welcomed by the mathematical community. Distinctive features of this book include: a concise but fully rigorous presentation, supplemented by a plethora of illustrations of a high technical and artistic caliber; a huge number of nontrivial examples and computations done in detail; a deeper and broader treatment of topics in comparison to most beginning books on algebraic topology; an extensive, and very concrete, treatment of the machinery of spectral sequences. The second edition contains an entirely new chapter on K-theory and the Riemann-Roch theorem (after Hirzebruch and Grothendieck).

Lectures on Algebraic Topology

An introductory textbook suitable for use in a course or for self-study, featuring broad coverage of the subject and a readable exposition, with many examples and exercises.

Lecture Notes in Algebraic Topology

This book offers an introductory course in algebraic topology. Starting with general topology, it discusses differentiable manifolds, cohomology, products and duality, the fundamental group, homology theory, and homotopy theory. From the reviews: "An interesting and original graduate text in topology and geometrya good lecturer can use this text to create a fine course.A beginning graduate student can use this text to learn a great deal of mathematics."—-MATHEMATICAL REVIEWS

Algebraic Topology

This book grew out of a graduate course on 3-manifolds and is intended for a mathematically experienced audience that is new to low-dimensional topology. The exposition begins with the definition of a manifold, explores possible additional structures on manifolds, discusses the classification of surfaces, introduces key foundational results for 3-manifolds, and provides an overview of knot theory. It then continues with more specialized topics by briefly considering triangulations of 3-manifolds, normal surface theory, and Heegaard splittings. The book finishes with a discussion of topics relevant to viewing 3-manifolds via the curve complex. With about 250 figures and more than 200 exercises, this book can serve as an excellent overview and starting point for the study of 3-manifolds.

Differential Forms in Algebraic Topology

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

A Basic Course in Algebraic Topology

This is essentially a book on singular homology and cohomology with special emphasis on products and manifolds. It does not treat homotopy theory except for some basic notions, some examples, and some applica tions of (co-)homology to homotopy. Nor does it deal with general(-ised) homology, but many formulations and arguments on singular homology are so chosen that they also apply to general homology. Because of these absences I have also omitted spectral sequences, their main applications in topology being to homotopy and general (co-)homology theory. Cech cohomology is treated in a simple ad hoc fashion for locally compact subsets of manifolds; a short systematic treatment for arbitrary spaces, emphasizing the universal property of the Cech-procedure, is contained in an appendix. The book grew out of a one-year's course on algebraic topology, and it can serve as a text for such a course. For a shorter basic course, say of half a year, one might use chapters II, III, IV (§§ 1-4), V (§§ 1-5, 7, 8), VI (§§ 3, 7, 9, 11, 12). As prerequisites the student should know the elementary parts of general topology, abelian group theory, and the language of categories - although our chapter I provides a little help with the latter two. For pedagogical reasons, I have treated integral homology only up to chapter VI; if a reader or teacher prefers to have general coefficients from the beginning he needs to make only minor adaptions.

Introduction to Smooth Manifolds

Based on lectures to advanced undergraduate and first-year graduate students, this is a thorough, sophisticated, and modern treatment of elementary algebraic topology, essentially from a homotopy theoretic viewpoint. Author C.R.F. Maunder provides examples and exercises; and notes and references at the end of each chapter trace the historical development of the subject.

Algebraic Topology

Manifolds play an important role in topology, geometry, complex analysis, algebra, and classical mechanics. Learning manifolds differs from most other introductory mathematics in that the subject matter is often completely unfamiliar. This introduction guides readers by explaining the roles manifolds play in diverse branches of mathematics and physics. The book begins with the basics of general topology and gently moves to manifolds, the fundamental group, and covering spaces.

Algebraic Topology

K-Theory

Homotopical Topology

An Introduction to Algebraic Topology

In recent years, many students have been introduced to topology in high school mathematics. Having met the Mobius band, the seven bridges of Konigsberg, Euler's polyhedron formula, and knots, the student is led to expect that these picturesque ideas will come to full flower in university topology courses. What a disappointment "undergraduate topology" proves to be! In most institutions it is either a service course for analysts, on abstract spaces, or else an introduction to homological algebra in which the only geometric activity is the completion of commutative diagrams. Pictures are kept to a minimum, and at the end the student still does nr~ understand the simplest topological facts, such as the rcason why knots exist. In my opinion, a well-balanced introduction to topology should stress its intuitive geometric aspect, while admitting the legitimate interest that analysts and algebraists have in the subject. At any rate, this is the aim of the present book. In support of this view, I have followed the historical development where practicable, since it clearly shows the influence of geometric thought at all stages. This is not to claim that topology received its main impetus from geometric recreations like the seven bridges; rather, it resulted from the l'isualization of problems from other parts of mathematics-complex analysis (Riemann), mechanics (Poincare), and group theory (Dehn). It is these connec tions to other parts of mathematics which make topology an important as well as a beautiful subject.

Introduction to Topological Manifolds

In most mathematics departments at major universities one of the three or four basic first-year graduate courses is in the subject of algebraic topology. This introductory textbook in algebraic topology is suitable for use in a course or for self-study, featuring broad coverage of the subject and a readable exposition, with many examples and exercises. The four main chapters present the basic material of the subject: fundamental group and covering spaces, homology and cohomology, higher homotopy groups, and homotopy theory generally. The author emphasizes the geometric aspects of the subject, which helps students gain intuition. A unique feature of the book is the inclusion of many optional topics which are not usually part of a first course due to time constraints, and for which elementary expositions are sometimes hard to find. Among these are: Bockstein and transfer homomorphisms, direct and inverse limits, H-spaces and Hopf algebras, the Brown representability theorem, the James reduced product, the Dold-Thom theorem, and a full exposition of Steenrod squares and powers. Researchers will also welcome this aspect of the book.

Elementary Topology

A modern, example-driven introduction to cubical diagrams and related topics such as homotopy limits and cosimplicial spaces.

Matrix Groups for Undergraduates

Algebraic topology is the study of the global properties of spaces by means of algebra. It is an important branch of modern mathematics with a wide degree of applicability to other fields, including geometric topology, differential geometry, functional analysis, differential equations, algebraic geometry, number theory, and theoretical physics. This book provides an introduction to the basic concepts and methods of algebraic topology for the beginner. It presents elements of both homology theory and homotopy theory, and includes various applications. The author's intention is to rely on the geometric approach by appealing to the reader's own intuition to help understanding. The numerous illustrations in the text also serve this purpose. Two features make the text different from the standard literature: first, special attention is given to providing explicit algorithms for calculating the homology groups and for manipulating the fundamental groups. Second, the book contains many exercises, all of which are supplied with hints or solutions. This makes the book suitable for both classroom use and for independent study.

Principles of Topology

Great first book on algebraic topology. Introduces (co)homology through singular theory.

Classical Topology and Combinatorial Group Theory

From the reviews: "The author has attempted an ambitious and most commendable project. [] The book contains much material that has not previously appeared in this format. The writing is clean and clear and the exposition is well motivated. [] This book is, all in all, a very admirable work and a valuable addition to the literature." Mathematical Reviews

Foundations of Hyperbolic Manifolds

This book is a well-informed and detailed analysis of the problems and development of algebraic topology, from Poincaré and Brouwer to Serre, Adams, and Thom. The author has examined each significant paper along this route and describes the steps and strategy of its proofs and its relation to other work. Previously, the history of the many technical developments of 20th-century mathematics had seemed to present insuperable obstacles to scholarship. This book demonstrates in the case of topology how these obstacles can be overcome, with enlightening results. Within its chosen boundaries the coverage of this book is superb. Read it! —MathSciNet

Basic Category Theory

Originally published: Philadelphia: Saunders College Publishing, 1989; slightly corrected.

Algebraic Topology

This volume deals with the theory of finite topological spaces and its relationship with the homotopy and simple homotopy theory of polyhedra. The interaction between their intrinsic combinatorial and topological structures makes finite spaces a useful tool for studying problems in Topology, Algebra and Geometry from a new perspective. In particular, the methods developed in this manuscript are used to study Quillen's conjecture on the poset of p-subgroups of a finite group and the Andrews-Curtis conjecture on the 3-deformability of contractible two-dimensional complexes. This self-contained work constitutes the first detailed exposition on the algebraic topology of finite spaces. It is intended for topologists and combinatorialists, but it is also recommended for advanced undergraduate students and graduate students with a modest knowledge of Algebraic Topology.

A History of Algebraic and Differential Topology, 1900 - 1960

Annotation. The book is intended as a text for a two-semester course in topology and algebraic topology at the advanced undergraduate orbeginning graduate level. There are over 500 exercises, 114 figures, numerous diagrams. The general direction of the book is towardhomotopy theory with a geometric point of view. This book would providea more than adequate background for a standard algebraic topology coursethat begins with homology theory. For more information seewww.bangor.ac.uk/r.brown/topgpds.htmlThis version dated April 19, 2006, has a number of corrections made.

Algebraic Topology

This book is an exposition of the theoretical foundations of hyperbolic manifolds. It is intended to be used both as a textbook and as a reference. Particular emphasis has been placed on readability and completeness of ar gument. The treatment of the material is for the most part elementary and self-contained. The reader is assumed to have a basic knowledge of algebra and topology at the first-year graduate level of an American university. The book is divided into three parts. The first part, consisting of Chap ters 1-7, is concerned with hyperbolic geometry and basic properties of discrete groups of isometries of hyperbolic space. The main results are the existence theorem for discrete reflection groups, the Bieberbach theorems, and Selberg's lemma. The second part, consisting of Chapters 8-12, is de voted to the theory of hyperbolic manifolds. The main results are Mostow's rigidity theorem and the determination of the structure of geometrically finite hyperbolic manifolds. The third part, consisting of Chapter 13, in tegrates the first two parts in a development of the theory of hyperbolic orbifolds. The main results are the construction of the universal orbifold covering space and Poincare's fundamental polyhedron theorem.

Topology and Geometry

Matrix groups touch an enormous spectrum of the mathematical arena. This textbook brings them into the undergraduate curriculum. It makes an excellent one-semester course for students familiar with linear and abstract algebra and prepares them for a graduate course on Lie groups. Matrix Groups for Undergraduates is concrete and example-driven, with geometric motivation and rigorous proofs. The story begins and ends with the rotations of a globe. In between, the author combines rigor and intuition to describe the basic objects of Lie theory: Lie algebras, matrix exponentiation, Lie brackets, maximal tori, homogeneous spaces, and roots. This second edition includes two new chapters that allow for an easier transition to the general theory of Lie groups.

Algebraic Topology

Algebraic topology is a basic part of modern mathematics, and some knowledge of this area is indispensable for any advanced work relating to geometry, including topology itself, differential geometry, algebraic geometry, and Lie groups. This book provides a detailed treatment of algebraic topology both for teachers of the subject and for advanced graduate students in mathematics either specializing in this area or continuing on to other fields. J. Peter May's approach reflects the enormous internal developments within algebraic topology over the past several decades, most of which are largely unknown to mathematicians in other fields. But he also retains the classical presentations of various topics where appropriate. Most chapters end with problems that further explore and refine the concepts presented. The final four chapters provide sketches of substantial areas of algebraic topology that are normally omitted from introductory texts, and the book concludes with a list of suggested readings for those interested in delving further into the field.

Introduction to 3-Manifolds

This self-contained treatment begins with three chapters on the basics of point-set topology, after which it proceeds to homology groups and continuous mapping, barycentric subdivision, and simplicial complexes. 1961 edition.

Cubical Homotopy Theory

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