

Advanced Modern Algebra

Third Edition, Part I

Joseph J. Rotman

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Advanced Modern Algebra Rotman Second Edition

Ian Malcolm Musson



Advanced Modern Algebra Rotman Second Edition:

Advanced Modern Algebra Joseph J. Rotman, 2010-08-11 This book is designed as a text for the first year of graduate algebra but it can also serve as a reference since it contains more advanced topics as well This second edition has a different organization than the first It begins with a discussion of the cubic and quartic equations which leads into permutations group theory and Galois theory for finite extensions infinite Galois theory is discussed later in the book The study of groups continues with finite abelian groups finitely generated groups are discussed later in the context of module theory Sylow theorems simplicity of projective unimodular groups free groups and presentations and the Nielsen Schreier theorem subgroups of free groups are free The study of commutative rings continues with prime and maximal ideals unique factorization noetherian rings Zorn's lemma and applications varieties and Gröbner bases Next noncommutative rings and modules are discussed treating tensor product projective injective and flat modules categories functors and natural transformations categorical constructions including direct and inverse limits and adjoint functors Then follow group representations Wedderburn Artin theorems character theory theorems of Burnside and Frobenius division rings Brauer groups and abelian categories Advanced linear algebra treats canonical forms for matrices and the structure of modules over PIDs followed by multilinear algebra Homology is introduced first for simplicial complexes then as derived functors with applications to Ext Tor and cohomology of groups crossed products and an introduction to algebraic K theory Finally the author treats localization Dedekind rings and algebraic number theory and homological dimensions The book ends with the proof that regular local rings have unique factorization Publisher's description *Advanced Linear Algebra* Nicholas Loehr, 2014-04-10 Designed for advanced undergraduate and beginning graduate students in linear or abstract algebra *Advanced Linear Algebra* covers theoretical aspects of the subject along with examples computations and proofs It explores a variety of advanced topics in linear algebra that highlight the rich interconnections of the subject to geometry algebra analysis combinatorics numerical computation and many other areas of mathematics The book's 20 chapters are grouped into six main areas algebraic structures matrices structured matrices geometric aspects of linear algebra modules and multilinear algebra The level of abstraction gradually increases as students proceed through the text moving from matrices to vector spaces to modules Each chapter consists of a mathematical vignette devoted to the development of one specific topic Some chapters look at introductory material from a sophisticated or abstract viewpoint while others provide elementary expositions of more theoretical concepts Several chapters offer unusual perspectives or novel treatments of standard results Unlike similar advanced mathematical texts this one minimizes the dependence of each chapter on material found in previous chapters so that students may immediately turn to the relevant chapter without first wading through pages of earlier material to access the necessary algebraic background and theorems Chapter summaries contain a structured list of the principal definitions and results End of chapter exercises aid students in digesting the material Students are encouraged to

use a computer algebra system to help solve computationally intensive exercises

Advanced Linear Algebra Nicholas A. Loehr, 2024-06-21 Designed for advanced undergraduate and beginning graduate students in linear or abstract algebra Advanced Linear Algebra covers theoretical aspects of the subject along with examples computations and proofs It explores a variety of advanced topics in linear algebra that highlight the rich interconnections of the subject to geometry algebra analysis combinatorics numerical computation and many other areas of mathematics The author begins with chapters introducing basic notation for vector spaces permutations polynomials and other algebraic structures The following chapters are designed to be mostly independent of each other so that readers with different interests can jump directly to the topic they want This is an unusual organization compared to many abstract algebra textbooks which require readers to follow the order of chapters Each chapter consists of a mathematical vignette devoted to the development of one specific topic Some chapters look at introductory material from a sophisticated or abstract viewpoint while others provide elementary expositions of more theoretical concepts Several chapters offer unusual perspectives or novel treatments of standard results A wide array of topics is included ranging from concrete matrix theory basic matrix computations determinants normal matrices canonical forms matrix factorizations and numerical algorithms to more abstract linear algebra modules Hilbert spaces dual vector spaces bilinear forms principal ideal domains universal mapping properties and multilinear algebra The book provides a bridge from elementary computational linear algebra to more advanced abstract aspects of linear algebra needed in many areas of pure and applied mathematics

Combinatorial Game Theory Aaron N. Siegel, 2023-11-20 It is wonderful to see advanced combinatorial game theory made accessible Siegel's expertise and enjoyable writing style make this book a perfect resource for anyone wanting to learn the latest developments and open problems in the field Erik Demaine MIT Aaron Siegel has been the major contributor to Combinatorial Game Theory over the last decade or so Now in this authoritative work he has made the latest results in the theory accessible so that the subject will achieve the place in mathematics that it deserves Richard Guy University of Calgary Combinatorial game theory is the study of two player games with no hidden information and no chance elements The theory assigns algebraic values to positions in such games and seeks to quantify the algebraic and combinatorial structure of their interactions Its modern form was introduced thirty years ago with the publication of the classic *Winning Ways for Your Mathematical Plays* by Berlekamp Conway and Guy and interest has rapidly increased in recent decades This book is a comprehensive and up to date introduction to the subject tracing its development from first principles and examples through many of its most recent advances Roughly half the book is devoted to a rigorous treatment of the classical theory the remaining material is an in depth presentation of topics that appear for the first time in textbook form including the theory of misère quotients and Berlekamp's generalized temperature theory Packed with hundreds of examples and exercises and meticulously cross referenced *Combinatorial Game Theory* will appeal equally to students instructors and research professionals More than forty open problems and conjectures are mentioned in the text highlighting

the many mysteries that still remain in this young and exciting field Aaron Siegel holds a Ph D in mathematics from the University of California Berkeley and has held positions at the Mathematical Sciences Research Institute and the Institute for Advanced Study He was a partner at Berkeley Quantitative a technology driven hedge fund and is presently employed by Twitter Inc

Lie Superalgebras and Enveloping Algebras Ian Malcolm Musson, 2012-04-04 Lie superalgebras are a natural generalization of Lie algebras having applications in geometry number theory gauge field theory and string theory This book develops the theory of Lie superalgebras their enveloping algebras and their representations The book begins with five chapters on the basic properties of Lie superalgebras including explicit constructions for all the classical simple Lie superalgebras Borel subalgebras which are more subtle in this setting are studied and described Contragredient Lie superalgebras are introduced allowing a unified approach to several results in particular to the existence of an invariant bilinear form on $\mathfrak{g}$ The enveloping algebra of a finite dimensional Lie superalgebra is studied as an extension of the enveloping algebra of the even part of the superalgebra By developing general methods for studying such extensions important information on the algebraic structure is obtained particularly with regard to primitive ideals Fundamental results such as the Poincare Birkhoff Witt Theorem are established Representations of Lie superalgebras provide valuable tools for understanding the algebras themselves as well as being of primary interest in applications to other fields Two important classes of representations are the Verma modules and the finite dimensional representations The fundamental results here include the Jantzen filtration the Harish Chandra homomorphism the Sapovalov determinant supersymmetric polynomials and Schur Weyl duality Using these tools the center can be explicitly described in the general linear and orthosymplectic cases In an effort to make the presentation as self contained as possible some background material is included on Lie theory ring theory Hopf algebras and combinatorics

Hyperbolic Knot Theory Jessica S. Purcell, 2020-10-06 This book provides an introduction to hyperbolic geometry in dimension three with motivation and applications arising from knot theory Hyperbolic geometry was first used as a tool to study knots by Riley and then Thurston in the 1970s By the 1980s combining work of Mostow and Prasad with Gordon and Luecke it was known that a hyperbolic structure on a knot complement in the 3 sphere gives a complete knot invariant However it remains a difficult problem to relate the hyperbolic geometry of a knot to other invariants arising from knot theory In particular it is difficult to determine hyperbolic geometric information from a knot diagram which is classically used to describe a knot This textbook provides background on these problems and tools to determine hyperbolic information on knots It also includes results and state of the art techniques on hyperbolic geometry and knot theory to date The book was written to be interactive with many examples and exercises Some important results are left to guided exercises The level is appropriate for graduate students with a basic background in algebraic topology particularly fundamental groups and covering spaces Some experience with some differential topology and Riemannian geometry will also be helpful

Combinatorics: The Art of Counting Bruce E. Sagan, 2020-10-16 This book is a gentle introduction to the

enumerative part of combinatorics suitable for study at the advanced undergraduate or beginning graduate level In addition to covering all the standard techniques for counting combinatorial objects the text contains material from the research literature which has never before appeared in print such as the use of quotient posets to study the Möbius function and characteristic polynomial of a partially ordered set or the connection between quasisymmetric functions and pattern avoidance The book assumes minimal background and a first course in abstract algebra should suffice The exposition is very reader friendly keeping a moderate pace using lots of examples emphasizing recurring themes and frankly expressing the delight the author takes in mathematics in general and combinatorics in particular

Invitation to Partial Differential Equations Mikhail Shubin, 2022-02-08 This book is based on notes from a beginning graduate course on partial differential equations Prerequisites for using the book are a solid undergraduate course in real analysis There are more than 100 exercises in the book Some of them are just exercises whereas others even though they may require new ideas to solve them provide additional important information about the subject It is a great pleasure to see this book written by a great master of the subject finally in print This treatment of a core part of mathematics and its applications offers the student both a solid foundation in basic calculations techniques in the subject as well as a basic introduction to the more general machinery e.g. distributions Sobolev spaces etc which are such a key part of any modern treatment As such this book is ideal for more advanced undergraduates as well as mathematically inclined students from engineering or the natural sciences Shubin has a lovely intuitive writing style which provides a gentle introduction to this beautiful subject Many good exercises and solutions are provided Rafe Mazzeo Stanford University This text provides an excellent semester's introduction to classical and modern topics in linear PDE suitable for students with a background in advanced calculus and Lebesgue integration The author intersperses treatments of the Laplace heat and wave equations with developments of various functional analytic tools particularly distribution theory and spectral theory introducing key concepts while deftly avoiding heavy technicalities Michael Taylor University of North Carolina Chapel Hill

Extrinsic Geometric Flows Ben Andrews, Bennett Chow, Christine Guenther, Mat Langford, 2022-03-02 Extrinsic geometric flows are characterized by a submanifold evolving in an ambient space with velocity determined by its extrinsic curvature The goal of this book is to give an extensive introduction to a few of the most prominent extrinsic flows namely the curve shortening flow the mean curvature flow the Gauss curvature flow the inverse mean curvature flow and fully nonlinear flows of mean curvature and inverse mean curvature type The authors highlight techniques and behaviors that frequently arise in the study of these and other flows To illustrate the broad applicability of the techniques developed they also consider general classes of fully nonlinear curvature flows The book is written at the level of a graduate student who has had a basic course in differential geometry and has some familiarity with partial differential equations It is intended also to be useful as a reference for specialists In general the authors provide detailed proofs although for some more specialized results they may only present the main ideas in such cases they provide

references for complete proofs A brief survey of additional topics with extensive references can be found in the notes and commentary at the end of each chapter

Shock Waves Tai-Ping Liu, 2021-10-12 This book presents the fundamentals of the shock wave theory The first part of the book Chapters 1 through 5 covers the basic elements of the shock wave theory by analyzing the scalar conservation laws The main focus of the analysis is on the explicit solution behavior This first part of the book requires only a course in multi variable calculus and can be used as a text for an undergraduate topics course In the second part of the book Chapters 6 through 9 this general theory is used to study systems of hyperbolic conservation laws This is a most significant well posedness theory for weak solutions of quasilinear evolutionary partial differential equations The final part of the book Chapters 10 through 14 returns to the original subject of the shock wave theory by focusing on specific physical models Potentially interesting questions and research directions are also raised in these chapters The book can serve as an introductory text for advanced undergraduate students and for graduate students in mathematics engineering and physical sciences Each chapter ends with suggestions for further reading and exercises for students

Lectures on Differential Topology Riccardo Benedetti, 2021-10-27 This book gives a comprehensive introduction to the theory of smooth manifolds maps and fundamental associated structures with an emphasis on bare hands approaches combining differential topological cut and paste procedures and applications of transversality In particular the smooth cobordism cup product is defined from scratch and used as the main tool in a variety of settings After establishing the fundamentals the book proceeds to a broad range of more advanced topics in differential topology including degree theory the Poincaré Hopf index theorem bordism characteristic numbers and the Pontryagin Thom construction Cobordism intersection forms are used to classify compact surfaces their quadratic enhancements are developed and applied to studying the homotopy groups of spheres the bordism group of immersed surfaces in a 3 manifold and congruences mod 16 for the signature of intersection forms of 4 manifolds Other topics include the high dimensional h cobordism theorem stressing the role of the Whitney trick a determination of the singleton bordism modules in low dimensions and proofs of parallelizability of orientable 3 manifolds and the Lickorish-Wallace theorem Nash manifolds and Nash's questions on the existence of real algebraic models are also discussed This book will be useful as a textbook for beginning masters and doctoral students interested in differential topology who have finished a standard undergraduate mathematics curriculum It emphasizes an active learning approach and exercises are included within the text as part of the flow of ideas Experienced readers may use this book as a source of alternative constructive approaches to results commonly presented in more advanced contexts with specialized techniques

Lectures on Poisson Geometry Marius Crainic, Rui Loja Fernandes, Ioan Mărcuț, 2021-10-14 This excellent book will be very useful for students and researchers wishing to learn the basics of Poisson geometry as well as for those who know something about the subject but wish to update and deepen their knowledge The authors philosophy that Poisson geometry is an amalgam of foliation theory symplectic geometry and Lie theory enables them to organize the book in

a very coherent way Alan Weinstein University of California at Berkeley This well written book is an excellent starting point for students and researchers who want to learn about the basics of Poisson geometry The topics covered are fundamental to the theory and avoid any drift into specialized questions they are illustrated through a large collection of instructive and interesting exercises The book is ideal as a graduate textbook on the subject but also for self study Eckhard Meinrenken University of Toronto

Hamilton-Jacobi Equations: Theory and Applications Hung Vinh Tran, 2021-09-17 This book gives an extensive survey of many important topics in the theory of Hamilton Jacobi equations with particular emphasis on modern approaches and viewpoints Firstly the basic well posedness theory of viscosity solutions for first order Hamilton Jacobi equations is covered Then the homogenization theory a very active research topic since the late 1980s but not covered in any standard textbook is discussed in depth Afterwards dynamical properties of solutions the Aubry Mather theory and weak Kolmogorov Arnold Moser KAM theory are studied Both dynamical and PDE approaches are introduced to investigate these theories Connections between homogenization dynamical aspects and the optimal rate of convergence in homogenization theory are given as well The book is self contained and is useful for a course or for references It can also serve as a gentle introductory reference to the homogenization theory

The \$K\$-book Charles A. Weibel, 2013-06-13 Informally K theory is a tool for probing the structure of a mathematical object such as a ring or a topological space in terms of suitably parameterized vector spaces and producing important intrinsic invariants which are useful in the study of algebra

Rational Points on Varieties Bjorn Poonen, 2023-08-10 This book is motivated by the problem of determining the set of rational points on a variety but its true goal is to equip readers with a broad range of tools essential for current research in algebraic geometry and number theory The book is unconventional in that it provides concise accounts of many topics instead of a comprehensive account of just one this is intentionally designed to bring readers up to speed rapidly Among the topics included are Brauer groups faithfully flat descent algebraic groups torsors and fppf cohomology the Weil conjectures and the Brauer Manin and descent obstructions A final chapter applies all these to study the arithmetic of surfaces The down to earth explanations and the over 100 exercises make the book suitable for use as a graduate level textbook but even experts will appreciate having a single source covering many aspects of geometry over an unrestricted ground field and containing some material that cannot be found elsewhere The origins of arithmetic or Diophantine geometry can be traced back to antiquity and it remains a lively and wide research domain up to our days The book by Bjorn Poonen a leading expert in the field opens doors to this vast field for many readers with different experiences and backgrounds It leads through various algebraic geometric constructions towards its central subject obstructions to existence of rational points Yuri Manin Max Planck Institute Bonn It is clear that my mathematical life would have been very different if a book like this had been around at the time I was a student Hendrik Lenstra University Leiden Understanding rational points on arbitrary algebraic varieties is the ultimate challenge We have conjectures but few results Poonen's book with its mixture of basic

constructions and openings into current research will attract new generations to the Queen of Mathematics Jean Louis Colliot Thélène Université Paris Sud A beautiful subject handled by a master Joseph Silverman Brown University Introduction to Global Analysis John Douglas Moore, 2017-12-15 During the last century global analysis was one of the main sources of interaction between geometry and topology One might argue that the core of this subject is Morse theory according to which the critical points of a generic smooth proper function on a manifold determine the homology of the manifold Morse envisioned applying this idea to the calculus of variations including the theory of periodic motion in classical mechanics by approximating the space of loops on by a finite dimensional manifold of high dimension Palais and Smale reformulated Morse's calculus of variations in terms of infinite dimensional manifolds and these infinite dimensional manifolds were found useful for studying a wide variety of nonlinear PDEs This book applies infinite dimensional manifold theory to the Morse theory of closed geodesics in a Riemannian manifold It then describes the problems encountered when extending this theory to maps from surfaces instead of curves It treats critical point theory for closed parametrized minimal surfaces in a compact Riemannian manifold establishing Morse inequalities for perturbed versions of the energy function on the mapping space It studies the bubbling which occurs when the perturbation is turned off together with applications to the existence of closed minimal surfaces The Morse Sard theorem is used to develop transversality theory for both closed geodesics and closed minimal surfaces This book is based on lecture notes for graduate courses on Topics in Differential Geometry taught by the author over several years The reader is assumed to have taken basic graduate courses in differential geometry and algebraic topology

Higher Order Fourier Analysis Terence Tao, 2012-12-30 Traditional Fourier analysis which has been remarkably effective in many contexts uses linear phase functions to study functions Some questions such as problems involving arithmetic progressions naturally lead to the use of quadratic or higher order phases Higher order Fourier analysis is a subject that has become very active only recently Gowers in groundbreaking work developed many of the basic concepts of this theory in order to give a new quantitative proof of Szemerédi's theorem on arithmetic progressions However there are also precursors to this theory in Weyl's classical theory of equidistribution as well as in Furstenberg's structural theory of dynamical systems This book which is the first monograph in this area aims to cover all of these topics in a unified manner as well as to survey some of the most recent developments such as the application of the theory to count linear patterns in primes The book serves as an introduction to the field giving the beginning graduate student in the subject a high level overview of the field The text focuses on the simplest illustrative examples of key results serving as a companion to the existing literature on the subject There are numerous exercises with which to test one's knowledge

Tensors: Geometry and Applications J. M. Landsberg, 2024-11-07 Tensors are ubiquitous in the sciences The geometry of tensors is both a powerful tool for extracting information from data sets and a beautiful subject in its own right This book has three intended uses a classroom textbook a reference work for researchers in the sciences and an account of classical and modern results in

aspects of the theory that will be of interest to researchers in geometry For classroom use there is a modern introduction to multilinear algebra and to the geometry and representation theory needed to study tensors including a large number of exercises For researchers in the sciences there is information on tensors in table format for easy reference and a summary of the state of the art in elementary language This is the first book containing many classical results regarding tensors Particular applications treated in the book include the complexity of matrix multiplication P versus NP signal processing phylogenetics and algebraic statistics For geometers there is material on secant varieties G varieties spaces with finitely many orbits and how these objects arise in applications discussions of numerous open questions in geometry arising in applications and expositions of advanced topics such as the proof of the Alexander Hirschowitz theorem and of the Weyman Kempf method for computing syzygies

An Introduction to Measure Theory Terence Tao, 2021-09-03 This is a graduate text introducing the fundamentals of measure theory and integration theory which is the foundation of modern real analysis The text focuses first on the concrete setting of Lebesgue measure and the Lebesgue integral which in turn is motivated by the more classical concepts of Jordan measure and the Riemann integral before moving on to abstract measure and integration theory including the standard convergence theorems Fubini's theorem and the Carathéodory extension theorem Classical differentiation theorems such as the Lebesgue and Rademacher differentiation theorems are also covered as are connections with probability theory The material is intended to cover a quarter or semester's worth of material for a first graduate course in real analysis There is an emphasis in the text on tying together the abstract and the concrete sides of the subject using the latter to illustrate and motivate the former The central role of key principles such as Littlewood's three principles as providing guiding intuition to the subject is also emphasized There are a large number of exercises throughout that develop key aspects of the theory and are thus an integral component of the text As a supplementary section a discussion of general problem solving strategies in analysis is also given The last three sections discuss optional topics related to the main matter of the book

Differential Algebraic Topology Matthias Kreck, 2010 This book presents a geometric introduction to the homology of topological spaces and the cohomology of smooth manifolds The author introduces a new class of stratified spaces so called stratifolds He derives basic concepts from differential topology such as Sard's theorem partitions of unity and transversality Based on this homology groups are constructed in the framework of stratifolds and the homology axioms are proved This implies that for nice spaces these homology groups agree with ordinary singular homology Besides the standard computations of homology groups using the axioms straightforward constructions of important homology classes are given The author also defines stratifold cohomology groups following an idea of Quillen Again certain important cohomology classes occur very naturally in this description for example the characteristic classes which are constructed in the book and applied later on One of the most fundamental results Poincaré duality is almost a triviality in this approach Some fundamental invariants such as the Euler characteristic and the signature are derived from

co homology groups These invariants play a significant role in some of the most spectacular results in differential topology In particular the author proves a special case of Hirzebruch s signature theorem and presents as a highlight Milnor s exotic 7 spheres This book is based on courses the author taught in Mainz and Heidelberg Readers should be familiar with the basic notions of point set topology and differential topology The book can be used for a combined introduction to differential and algebraic topology as well as for a quick presentation of co homology in a course about differential geometry

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