

# Representation Theory A Homological Algebra Point Of View Algebra And Applications

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## **Basic Representation Theory of Algebras** - Ibrahim Assem 2020-04-03

This textbook introduces the representation theory of algebras by focusing on two of its most important aspects: the Auslander-Reiten theory and the study of the radical of a module category. It starts by introducing and describing several characterisations of the radical of a module category, then presents the central concepts of irreducible morphisms and almost split sequences, before providing the definition of the Auslander-Reiten quiver, which encodes much of the information on the module category. It then turns to the study of endomorphism algebras, leading on one hand to the definition of the Auslander algebra and on the other to tilting theory. The book ends with selected properties of representation-finite algebras, which are now the best understood class of algebras. Intended for graduate students in representation theory, this book is also of interest to any mathematician wanting to learn the fundamentals of this rapidly growing field. A graduate course in non-commutative or homological algebra, which is standard in most universities, is a prerequisite for readers of this book.

## Representation Theory and Beyond - Jan Šťovíček 2020-11-13

This volume contains the proceedings of the Workshop and 18th International Conference on Representations of Algebras (ICRA 2018) held from August 8-17, 2018, in Prague, Czech Republic. It presents several themes of contemporary representation theory together with some new tools, such as stable  $\infty$ -categories, stable derivators, and contramodules. In the first part, expanded lecture notes of four courses delivered at the workshop are presented, covering the representation theory of finite sets with correspondences, geometric theory of quiver Grassmannians, recent applications of contramodules to tilting theory, as well as symmetries in the representation theory over an abstract stable homotopy theory. The second part consists of six more-advanced papers based on plenary talks of the conference, presenting selected topics from contemporary representation theory: recollements and purity, maximal green sequences, cohomological Hall algebras, Hochschild cohomology of associative algebras, cohomology of local selfinjective algebras, and the higher Auslander-Reiten theory studied via homotopy theory.

## **Geometric and Topological Aspects of the Representation Theory of Finite Groups** - Jon F. Carlson 2018-10-04

These proceedings comprise two workshops celebrating the accomplishments of David J. Benson on the occasion of his sixtieth birthday. The papers presented at the meetings were representative of the many mathematical subjects he has worked on, with an emphasis on group representations and cohomology. The first workshop was titled "Groups, Representations, and Cohomology" and held from June 22 to June 27, 2015 at Sabhal Mòr Ostaig on the Isle of Skye, Scotland. The second was a combination of a summer school and workshop on the subject of "Geometric Methods in the Representation Theory of Finite Groups" and took place at the Pacific Institute for the Mathematical Sciences at the University of British Columbia in Vancouver from July 27 to August 5, 2016. The contents of the volume include a composite of both summer school material and workshop-derived survey articles on geometric and topological aspects of the representation theory of finite groups. The mission of the annually sponsored Summer Schools is to train and draw new students, and help Ph.D students transition to independent research.

## *Gorenstein Homological Algebra* - Alina Iacob 2018-08-06

Gorenstein homological algebra is an important area of mathematics, with applications in commutative and noncommutative algebra, model category theory, representation theory, and algebraic geometry. While in classical homological algebra the existence of the projective, injective, and flat resolutions over arbitrary rings are well known, things are a little different when it comes to Gorenstein homological algebra. The main open problems in this area deal with the existence of the Gorenstein injective, Gorenstein projective, and Gorenstein flat resolutions. Gorenstein Homological Algebra is especially suitable for graduate students interested in homological algebra and its applications.

## *Kac-Moody Groups, their Flag Varieties and Representation Theory* - Shrawan Kumar 2012-12-06

Kac-Moody Lie algebras  $\mathfrak{g}$  were introduced in the mid-1960s independently by V. Kac and R. Moody, generalizing the finite-dimensional semisimple Lie algebras which we refer to as the finite case. The theory has undergone tremendous developments in various directions and connections with diverse areas abound, including mathematical physics, so much so that this theory has become a standard tool in mathematics. A detailed treatment of the Lie algebra aspect of the theory can be found in V. Kac's book [Kac-90]. This self-contained work treats the algebro-geometric and the topological aspects of Kac-Moody theory from scratch. The emphasis is on the study of the Kac-Moody groups  $G$  and their flag varieties  $X/Y$ , including their detailed construction, and their applications to the representation theory of  $\mathfrak{g}$ . In the finite case,  $G$  is nothing but a semisimple  $Y$  simply-connected algebraic group and  $X$  is the flag variety  $G/P$  for a parabolic subgroup  $P$  of  $G$ .

## **A Journey Through Representation Theory** - Caroline Gruson 2018-10-23

This text covers a variety of topics in representation theory and is intended for graduate students and more advanced researchers who are interested in the field. The book begins with classical representation theory of finite groups over complex numbers and ends with results on representation theory of quivers. The text includes in particular infinite-dimensional unitary representations for abelian groups, Heisenberg groups and  $SL(2)$ , and representation theory of finite-dimensional algebras. The last chapter is devoted to some applications of quivers, including Harish-Chandra modules for  $SL(2)$ . Ample examples are provided and some are revisited with a different approach when new methods are introduced, leading to deeper results. Exercises are spread throughout each chapter. Prerequisites include an advanced course in linear algebra that covers Jordan normal forms and tensor products as well as basic results on groups and rings.

## **Homological Algebra of Semimodules and Semicontramodules** - Leonid Positselski 2010-09-06

This book provides comprehensive coverage on semi-infinite homology and cohomology of associative algebraic structures. It features rich representation-theoretic and algebro-geometric examples and applications.

## A Course in Finite Group Representation Theory - Peter Webb 2016-08-19

This graduate-level text provides a thorough grounding in the representation theory of finite groups over fields and rings. The book provides a balanced and comprehensive account of the subject, detailing the methods needed to analyze representations that arise in many areas of mathematics. Key topics include the

construction and use of character tables, the role of induction and restriction, projective and simple modules for group algebras, indecomposable representations, Brauer characters, and block theory. This classroom-tested text provides motivation through a large number of worked examples, with exercises at the end of each chapter that test the reader's knowledge, provide further examples and practice, and include results not proven in the text. Prerequisites include a graduate course in abstract algebra, and familiarity with the properties of groups, rings, field extensions, and linear algebra.

[Relative Nonhomogeneous Koszul Duality](#) - Leonid Positselski 2022-02-10

This research monograph develops the theory of relative nonhomogeneous Koszul duality. Koszul duality is a fundamental phenomenon in homological algebra and related areas of mathematics, such as algebraic topology, algebraic geometry, and representation theory. Koszul duality is a popular subject of contemporary research. This book, written by one of the world's leading experts in the area, includes the homogeneous and nonhomogeneous quadratic duality theory over a nonsemisimple, noncommutative base ring, the Poincaré–Birkhoff–Witt theorem generalized to this context, and triangulated equivalences between suitable exotic derived categories of modules, curved DG comodules, and curved DG contramodules. The thematic example, meaning the classical duality between the ring of differential operators and the de Rham DG algebra of differential forms, involves some of the most important objects of study in the contemporary algebraic and differential geometry. For the first time in the history of Koszul duality the derived D- $\Omega$  duality is included into a general framework. Examples highly relevant for algebraic and differential geometry are discussed in detail.

[A Tour of Representation Theory](#) - Martin Lorenz 2018

Representation theory investigates the different ways in which a given algebraic object—such as a group or a Lie algebra—can act on a vector space. Besides being a subject of great intrinsic beauty, the theory enjoys the additional benefit of having applications in myriad contexts outside pure mathematics, including quantum field theory and the study of molecules in chemistry. Adopting a panoramic viewpoint, this book offers an introduction to four different flavors of representation theory: representations of algebras, groups, Lie algebras, and Hopf algebras. A separate part of the book is devoted to each of these areas and they are all treated in sufficient depth to enable and hopefully entice the reader to pursue research in representation theory. The book is intended as a textbook for a course on representation theory, which could immediately follow the standard graduate abstract algebra course, and for subsequent more advanced reading courses. Therefore, more than 350 exercises at various levels of difficulty are included. The broad range of topics covered will also make the text a valuable reference for researchers in algebra and related areas and a source for graduate and postgraduate students wishing to learn more about representation theory by self-study.

[A Course in Homological Algebra](#) - P.J. Hilton 2013-03-09

In this chapter we are largely influenced in our choice of material by the demands of the rest of the book. However, we take the view that this is an opportunity for the student to grasp basic categorical notions which permeate so much of mathematics today, including, of course, algebraic topology, so that we do not allow ourselves to be rigidly restricted by our immediate objectives. A reader totally unfamiliar with category theory may find it easiest to restrict his first reading of Chapter II to Sections 1 to 6; large parts of the book are understandable with the material presented in these sections. Another reader, who had already met many examples of categorical formulations and concepts might, in fact, prefer to look at Chapter II before reading Chapter I. Of course the reader thoroughly familiar with category theory could, in principal, omit Chapter II, except perhaps to familiarize himself with the notations employed. In Chapter III we begin the proper study of homological algebra by looking in particular at the group  $\text{Ext}(A, B)$ , where  $A$  and  $B$  are  $A$ -modules. It is shown how this group can be calculated by means of a projective presentation of  $A$ , or an injective presentation of  $B$ ; and how it may also be identified with the group of equivalence classes of extensions of the quotient module  $A/B$  by the submodule  $B$ .

[Representation Theory of Finite Groups: a Guidebook](#) - David A. Craven 2019-08-30

This book provides an accessible introduction to the state of the art of representation theory of finite groups. Starting from a basic level that is summarized at the start, the book proceeds to cover topics of current research interest, including open problems and conjectures. The central themes of the book are

block theory and module theory of group representations, which are comprehensively surveyed with a full bibliography. The individual chapters cover a range of topics within the subject, from blocks with cyclic defect groups to representations of symmetric groups. Assuming only modest background knowledge at the level of a first graduate course in algebra, this guidebook, intended for students taking first steps in the field, will also provide a reference for more experienced researchers. Although no proofs are included, end-of-chapter exercises make it suitable for student seminars.

[Surveys in Representation Theory of Algebras](#) - Alex Martsinkovsky 2018-09-12

This volume contains selected expository lectures delivered at the annual Maurice Auslander Distinguished Lectures and International Conference over the last several years. Reflecting the diverse landscape of modern representation theory of algebras, the selected articles include: a quick introduction to silting modules; a survey on the first decade of co-t-structures in triangulated categories; a functorial approach to the notion of module; a representation-theoretic approach to recollements in abelian categories; new examples of applications of relative homological algebra; connections between Coxeter groups and quiver representations; and recent progress on limits of approximation theory.

[Homological Theory of Representations](#) - Henning Krause 2021-11-18

This book for advanced graduate students and researchers discusses representations of associative algebras and their homological theory.

[Algebras, Quivers and Representations](#) - Aslak Bakke Buan 2013-08-24

This book features survey and research papers from The Abel Symposium 2011: Algebras, quivers and representations, held in Balestrand, Norway 2011. It examines a very active research area that has had a growing influence and profound impact in many other areas of mathematics like, commutative algebra, algebraic geometry, algebraic groups and combinatorics. This volume illustrates and extends such connections with algebraic geometry, cluster algebra theory, commutative algebra, dynamical systems and triangulated categories. In addition, it includes contributions on further developments in representation theory of quivers and algebras. *Algebras, Quivers and Representations* is targeted at researchers and graduate students in algebra, representation theory and triangulate categories.

[Representation Theory of Finite Groups and Associative Algebras](#) - Charles W. Curtis 2006

Provides an introduction to various aspects of the representation theory of finite groups. This book covers such topics as general non-commutative algebras, Frobenius algebras, representations over non-algebraically closed fields and fields of non-zero characteristic, and integral representations.

[An Introduction to Homological Algebra](#) - Charles A. Weibel 1995-10-27

The landscape of homological algebra has evolved over the last half-century into a fundamental tool for the working mathematician. This book provides a unified account of homological algebra as it exists today. The historical connection with topology, regular local rings, and semi-simple Lie algebras are also described. This book is suitable for second or third year graduate students. The first half of the book takes as its subject the canonical topics in homological algebra: derived functors, Tor and Ext, projective dimensions and spectral sequences. Homology of group and Lie algebras illustrate these topics. Intermingled are less canonical topics, such as the derived inverse limit functor  $\lim^1$ , local cohomology, Galois cohomology, and affine Lie algebras. The last part of the book covers less traditional topics that are a vital part of the modern homological toolkit: simplicial methods, Hochschild and cyclic homology, derived categories and total derived functors. By making these tools more accessible, the book helps to break down the technological barrier between experts and casual users of homological algebra.

[Building Bridges Between Algebra and Topology](#) - Wojciech Chachólski 2018-03-31

This volume presents an elaborated version of lecture notes for two advanced courses: (Re)Emerging methods in Commutative Algebra and Representation Theory and Building Bridges Between Algebra and Topology, held at the CRM in the spring of 2015. Homological algebra is a rich and ubiquitous area; it is both an active field of research and a widespread toolbox for many mathematicians. Together, these notes introduce recent applications and interactions of homological methods in commutative algebra, representation theory and topology, narrowing the gap between specialists from different areas wishing to acquaint themselves with a rapidly growing field. The covered topics range from a fresh introduction to the growing area of support theory for triangulated categories to the striking consequences of the formulation

in the homotopy theory of classical concepts in commutative algebra. Moreover, they also include a higher categories view of Hall algebras and an introduction to the use of idempotent functors in algebra and topology.

*Trends in Representation Theory of Algebras and Related Topics* - Andrzej Skowroński 2008

This book is concerned with recent trends in the representation theory of algebras and its exciting interaction with geometry, topology, commutative algebra, Lie algebras, quantum groups, homological algebra, invariant theory, combinatorics, model theory and theoretical physics. The collection of articles, written by leading researchers in the field, is conceived as a sort of handbook providing easy access to the present state of knowledge and stimulating further development. The topics under discussion include diagram algebras, Brauer algebras, cellular algebras, quasi-hereditary algebras, Hall algebras, Hecke algebras, symplectic reflection algebras, Cherednik algebras, Kashiwara crystals, Fock spaces, preprojective algebras, cluster algebras, rank varieties, varieties of algebras and modules, moduli of representations of quivers, semi-invariants of quivers, Cohen-Macaulay modules, singularities, coherent sheaves, derived categories, spectral representation theory, Coxeter polynomials, Auslander-Reiten theory, Calabi-Yau triangulated categories, Poincaré duality spaces, selfinjective algebras, periodic algebras, stable module categories, Hochschild cohomologies, deformations of algebras, Galois coverings of algebras, tilting theory, algebras of small homological dimensions, representation types of algebras, and model theory. This book consists of fifteen self-contained expository survey articles and is addressed to researchers and graduate students in algebra as well as a broader mathematical community. They contain a large number of open problems and give new perspectives for research in the field.

*Algebra 3* - Ramji Lal 2021-02-27

This book, the third book in the four-volume series in algebra, deals with important topics in homological algebra, including abstract theory of derived functors, sheaf co-homology, and an introduction to étale and  $l$ -adic co-homology. It contains four chapters which discuss homology theory in an abelian category together with some important and fundamental applications in geometry, topology, algebraic geometry (including basics in abstract algebraic geometry), and group theory. The book will be of value to graduate and higher undergraduate students specializing in any branch of mathematics. The author has tried to make the book self-contained by introducing relevant concepts and results required. Prerequisite knowledge of the basics of algebra, linear algebra, topology, and calculus of several variables will be useful. *(Mostly) Commutative Algebra* - Antoine Chambert-Loir 2021-04-08

This book stems from lectures on commutative algebra for 4th-year university students at two French universities (Paris and Rennes). At that level, students have already followed a basic course in linear algebra and are essentially fluent with the language of vector spaces over fields. The topics introduced include arithmetic of rings, modules, especially principal ideal rings and the classification of modules over such rings, Galois theory, as well as an introduction to more advanced topics such as homological algebra, tensor products, and algebraic concepts involved in algebraic geometry. More than 300 exercises will allow the reader to deepen his understanding of the subject. The book also includes 11 historical vignettes about mathematicians who contributed to commutative algebra.

*Calogero-Moser Systems and Representation Theory* - Pavel Etingof 2007

Calogero-Moser systems, which were originally discovered by specialists in integrable systems, are currently at the crossroads of many areas of mathematics and within the scope of interests of many mathematicians. More specifically, these systems and their generalizations turned out to have intrinsic connections with such fields as algebraic geometry (Hilbert schemes of surfaces), representation theory (double affine Hecke algebras, Lie groups, quantum groups), deformation theory (symplectic reflection algebras), homological algebra (Koszul algebras), Poisson geometry, etc. The goal of the present lecture notes is to give an introduction to the theory of Calogero-Moser systems, highlighting their interplay with these fields. Since these lectures are designed for non-experts, the author gives short introductions to each of the subjects involved and provides a number of exercises.

*Perverse Sheaves and Applications to Representation Theory* - Pramod N. Achar 2021-09-27

Since its inception around 1980, the theory of perverse sheaves has been a vital tool of fundamental importance in geometric representation theory. This book, which aims to make this theory accessible to

students and researchers, is divided into two parts. The first six chapters give a comprehensive account of constructible and perverse sheaves on complex algebraic varieties, including such topics as Artin's vanishing theorem, smooth descent, and the nearby cycles functor. This part of the book also has a chapter on the equivariant derived category, and brief surveys of side topics including étale and  $l$ -adic sheaves,  $D$ -modules, and algebraic stacks. The last four chapters of the book show how to put this machinery to work in the context of selected topics in geometric representation theory: Kazhdan-Lusztig theory; Springer theory; the geometric Satake equivalence; and canonical bases for quantum groups. Recent developments such as the  $p$ -canonical basis are also discussed. The book has more than 250 exercises, many of which focus on explicit calculations with concrete examples. It also features a 4-page "Quick Reference" that summarizes the most commonly used facts for computations, similar to a table of integrals in a calculus textbook.

**Elements of the Representation Theory of Associative Algebras: Volume 1** - Ibrahim Assem 2006-02-13

This is the first of a two-volume set that provides a modern account of the representation theory of finite dimensional associative algebras over an algebraically closed field. The subject is presented from the perspective of linear representations of quivers and homological algebra. The treatment is self-contained and provides an elementary and up-to-date introduction to the subject using quiver-theoretical techniques and the theory of almost split sequences as well as tilting theory and the use of integral quadratic forms. Much of this material has never appeared before in book form. The book is primarily addressed to graduate students starting research in the representation theory of algebras, but it will also be of interest to mathematicians in other fields. The text includes many illustrative examples and a large number of exercises at the end of each of the ten chapters. Proofs are presented in complete detail, making the book suitable for courses, seminars, and self-study. Book jacket.

**Homological Methods, Representation Theory, and Cluster Algebras** - Ibrahim Assem 2018-12-22

This text presents six mini-courses, all devoted to interactions between representation theory of algebras, homological algebra, and the new ever-expanding theory of cluster algebras. The interplay between the topics discussed in this text will continue to grow and this collection of courses stands as a partial testimony to this new development. The courses are useful for any mathematician who would like to learn more about this rapidly developing field; the primary aim is to engage graduate students and young researchers. Prerequisites include knowledge of some noncommutative algebra or homological algebra. Homological algebra has always been considered as one of the main tools in the study of finite-dimensional algebras. The strong relationship with cluster algebras is more recent and has quickly established itself as one of the important highlights of today's mathematical landscape. This connection has been fruitful to both areas—representation theory provides a categorification of cluster algebras, while the study of cluster algebras provides representation theory with new objects of study. The six mini-courses comprising this text were delivered March 7–18, 2016 at a CIMPA (Centre International de Mathématiques Pures et Appliquées) research school held at the Universidad Nacional de Mar del Plata, Argentina. This research school was dedicated to the founder of the Argentinian research group in representation theory, M.I. Platzeck. The courses held were: Advanced homological algebra Introduction to the representation theory of algebras Auslander-Reiten theory for algebras of infinite representation type Cluster algebras arising from surfaces Cluster tilted algebras Cluster characters Introduction to  $K$ -theory Brauer graph algebras and applications to cluster algebras

**Representations and Cohomology: Volume 2, Cohomology of Groups and Modules** - D. J. Benson 1991-08-22

A further introduction to modern developments in the representation theory of finite groups and associative algebras.

**Finite Dimensional Algebras** - Yurj A. Drozd 2012-12-06

This English edition has an additional chapter "Elements of Homological Algebra". Homological methods appear to be effective in many problems in the theory of algebras; we hope their inclusion makes this book more complete and self-contained as a textbook. We have also taken this occasion to correct several inaccuracies and errors in the original Russian edition. We should like to express our gratitude to V. Dlab

who has not only meticulously translated the text, but has also contributed by writing an Appendix devoted to a new important class of algebras, viz. quasi-hereditary algebras. Finally, we are indebted to the publishers, Springer-Verlag, for enabling this book to reach such a wide audience in the world of mathematical community. Kiev, February 1993 Yu.A. Drozd V.V. Kirichenko Preface The theory of finite dimensional algebras is one of the oldest branches of modern algebra. Its origin is linked to the work of Hamilton who discovered the famous algebra of quaternions, and Cayley who developed matrix theory. Later finite dimensional algebras were studied by a large number of mathematicians including B. Peirce, C.S. Peirce, Clifford, Weierstrass, Dedekind, Jordan and Frobenius. At the end of the last century T. Molien and E. Cartan described the semisimple algebras over the complex and real fields and paved the first steps towards the study of non-semi simple algebras.

**Introduction to Representation Theory** - Pavel I. Etingof 2011

Very roughly speaking, representation theory studies symmetry in linear spaces. It is a beautiful mathematical subject which has many applications, ranging from number theory and combinatorics to geometry, probability theory, quantum mechanics, and quantum field theory. The goal of this book is to give a "holistic" introduction to representation theory, presenting it as a unified subject which studies representations of associative algebras and treating the representation theories of groups, Lie algebras, and quivers as special cases. Using this approach, the book covers a number of standard topics in the representation theories of these structures. Theoretical material in the book is supplemented by many problems and exercises which touch upon a lot of additional topics; the more difficult exercises are provided with hints. The book is designed as a textbook for advanced undergraduate and beginning graduate students. It should be accessible to students with a strong background in linear algebra and a basic knowledge of abstract algebra.

**An Introduction to Quiver Representations** - Harm Derksen 2017-11-29

This book is an introduction to the representation theory of quivers and finite dimensional algebras. It gives a thorough and modern treatment of the algebraic approach based on Auslander-Reiten theory as well as the approach based on geometric invariant theory. The material in the opening chapters is developed starting slowly with topics such as homological algebra, Morita equivalence, and Gabriel's theorem. Next, the book presents Auslander-Reiten theory, including almost split sequences and the Auslander-Reiten transform, and gives a proof of Kac's generalization of Gabriel's theorem. Once this basic material is established, the book goes on with developing the geometric invariant theory of quiver representations. The book features the exposition of the saturation theorem for semi-invariants of quiver representations and its application to Littlewood-Richardson coefficients. In the final chapters, the book exposes tilting modules, exceptional sequences and a connection to cluster categories. The book is suitable for a graduate course in quiver representations and has numerous exercises and examples throughout the text. The book will also be of use to experts in such areas as representation theory, invariant theory and algebraic geometry, who want to learn about applications of quiver representations to their fields.

**Representation Theory of Artin Algebras** - Maurice Auslander 1997-08-21

This book is an introduction to the contemporary representation theory of Artin algebras, by three very distinguished practitioners in the field. Beyond assuming some first-year graduate algebra and basic homological algebra, the presentation is entirely self-contained, so the book is suitable for any mathematicians (especially graduate students) wanting an introduction to this active field. '...written in a clear comprehensive style with full proofs. It can very well serve as an excellent reference as well as a textbook for graduate students.' EMS Newsletter

**Algebras and Representation Theory** - Karin Erdmann 2018-09-07

This carefully written textbook provides an accessible introduction to the representation theory of algebras, including representations of quivers. The book starts with basic topics on algebras and modules, covering fundamental results such as the Jordan-Hölder theorem on composition series, the Artin-Wedderburn theorem on the structure of semisimple algebras and the Krull-Schmidt theorem on indecomposable modules. The authors then go on to study representations of quivers in detail, leading to a complete proof of Gabriel's celebrated theorem characterizing the representation type of quivers in terms of Dynkin diagrams. Requiring only introductory courses on linear algebra and groups, rings and fields, this textbook

is aimed at undergraduate students. With numerous examples illustrating abstract concepts, and including more than 200 exercises (with solutions to about a third of them), the book provides an example-driven introduction suitable for self-study and use alongside lecture courses.

**A Course in Homological Algebra** - Peter J. Hilton 2012-09-05

Homological algebra has found a large number of applications in many fields ranging from finite and infinite group theory to representation theory, number theory, algebraic topology and sheaf theory. In the new edition of this broad introduction to the field, the authors address a number of select topics and describe their applications, illustrating the range and depth of their developments. A comprehensive set of exercises is included.

**Algebra I** - Alexey L. Gorodentsev 2016-11-24

This book is the first volume of an intensive "Russian-style" two-year graduate course in abstract algebra, and introduces readers to the basic algebraic structures - fields, rings, modules, algebras, groups, and categories - and explains the main principles of and methods for working with them. The course covers substantial areas of advanced combinatorics, geometry, linear and multilinear algebra, representation theory, category theory, commutative algebra, Galois theory, and algebraic geometry - topics that are often overlooked in standard undergraduate courses. This textbook is based on courses the author has conducted at the Independent University of Moscow and at the Faculty of Mathematics in the Higher School of Economics. The main content is complemented by a wealth of exercises for class discussion, some of which include comments and hints, as well as problems for independent study.

**Homological Methods, Representation Theory, and Cluster Algebras** - Ibrahim Assem 2018-05-18

This text presents six mini-courses, all devoted to interactions between representation theory of algebras, homological algebra, and the new ever-expanding theory of cluster algebras. The interplay between the topics discussed in this text will continue to grow and this collection of courses stands as a partial testimony to this new development. The courses are useful for any mathematician who would like to learn more about this rapidly developing field; the primary aim is to engage graduate students and young researchers. Prerequisites include knowledge of some noncommutative algebra or homological algebra. Homological algebra has always been considered as one of the main tools in the study of finite-dimensional algebras. The strong relationship with cluster algebras is more recent and has quickly established itself as one of the important highlights of today's mathematical landscape. This connection has been fruitful to both areas—representation theory provides a categorification of cluster algebras, while the study of cluster algebras provides representation theory with new objects of study. The six mini-courses comprising this text were delivered March 7–18, 2016 at a CIMPA (Centre International de Mathématiques Pures et Appliquées) research school held at the Universidad Nacional de Mar del Plata, Argentina. This research school was dedicated to the founder of the Argentinian research group in representation theory, M.I. Platzeck. The courses held were: Advanced homological algebra Introduction to the representation theory of algebras Auslander-Reiten theory for algebras of infinite representation type Cluster algebras arising from surfaces Cluster tilted algebras Cluster characters Introduction to K-theory Brauer graph algebras and applications to cluster algebras

**Extended Abstracts Spring 2015** - Dolores Herbera 2016-10-23

This book includes 33 expanded abstracts of selected talks given at the two workshops "Homological Bonds Between Commutative Algebra and Representation Theory" and "Brave New Algebra: Opening Perspectives," and the conference "Opening Perspectives in Algebra, Representations, and Topology," held at the Centre de Recerca Matemàtica (CRM) in Barcelona between January and June 2015. These activities were part of the one-semester intensive research program "Interactions Between Representation Theory, Algebraic Topology and Commutative Algebra (IRTATCA)." Most of the abstracts present preliminary versions of not-yet published results and cover a large number of topics (including commutative and non commutative algebra, algebraic topology, singularity theory, triangulated categories, representation theory) overlapping with homological methods. This comprehensive book is a valuable resource for the community of researchers interested in homological algebra in a broad sense, and those curious to learn the latest developments in the area. It appeals to established researchers as well as PhD and postdoctoral students who want to learn more about the latest advances in these highly active fields of research.

*Characters of Groups and Lattices over Orders* - Alexander Zimmermann 2022-01-19

This is the first textbook leading coherently from classical character theory to the theory of lattices over orders and integral representations of finite groups. After the introduction to simple modules allowing a non degenerate invariant bilinear form in any characteristic the author illustrates step by step the approach given by Sin and Willems. Dirichlet characters and results on primes in arithmetic progressions are given as applications.

*Representations and Cohomology: Volume 1, Basic Representation Theory of Finite Groups and Associative Algebras* - D. J. Benson 1998-06-18

An introduction to modern developments in the representation theory of finite groups and associative algebras.

**Algebra II** - Alexey L. Gorodentsev 2017-02-12

This book is the second volume of an intensive "Russian-style" two-year undergraduate course in abstract algebra, and introduces readers to the basic algebraic structures - fields, rings, modules, algebras, groups, and categories - and explains the main principles of and methods for working with them. The course covers substantial areas of advanced combinatorics, geometry, linear and multilinear algebra, representation theory, category theory, commutative algebra, Galois theory, and algebraic geometry - topics that are often overlooked in standard undergraduate courses. This textbook is based on courses the author has conducted at the Independent University of Moscow and at the Faculty of Mathematics in the Higher School of Economics. The main content is complemented by a wealth of exercises for class discussion, some of which include comments and hints, as well as problems for independent study.

**Homological Theory of Representations** - Henning Krause 2021-11-18

Modern developments in representation theory rely heavily on homological methods. This book for advanced graduate students and researchers introduces these methods from their foundations up and

discusses several landmark results that illustrate their power and beauty. Categorical foundations include abelian and derived categories, with an emphasis on localisation, spectra, and purity. The representation theoretic focus is on module categories of Artin algebras, with discussions of the representation theory of finite groups and finite quivers. Also covered are Gorenstein and quasi-hereditary algebras, including Schur algebras, which model polynomial representations of general linear groups, and the Morita theory of derived categories via tilting objects. The final part is devoted to a systematic introduction to the theory of purity for locally finitely presented categories, covering pure-injectives, definable subcategories, and Ziegler spectra. With its clear, detailed exposition of important topics in modern representation theory, many of which were unavailable in one volume until now, it deserves a place in every representation theorist's library.

**Representation Theory** - Alexander Zimmermann 2014-08-15

Introducing the representation theory of groups and finite dimensional algebras, first studying basic non-commutative ring theory, this book covers the necessary background on elementary homological algebra and representations of groups up to block theory. It further discusses vertices, defect groups, Green and Brauer correspondences and Clifford theory. Whenever possible the statements are presented in a general setting for more general algebras, such as symmetric finite dimensional algebras over a field. Then, abelian and derived categories are introduced in detail and are used to explain stable module categories, as well as derived categories and their main invariants and links between them. Group theoretical applications of these theories are given - such as the structure of blocks of cyclic defect groups - whenever appropriate. Overall, many methods from the representation theory of algebras are introduced. Representation Theory assumes only the most basic knowledge of linear algebra, groups, rings and fields and guides the reader in the use of categorical equivalences in the representation theory of groups and algebras. As the book is based on lectures, it will be accessible to any graduate student in algebra and can be used for self-study as well as for classroom use.