

# eisenbud commutative algebra

## Decoding Eisenbud's Commutative Algebra: A Comprehensive Guide

Introduction:

Stepping into the world of commutative algebra can feel like entering a dense, abstract jungle. But fear not! This comprehensive guide navigates the intricacies of David Eisenbud's renowned textbook, *Commutative Algebra with a View Toward Algebraic Geometry*. We'll dissect its core concepts, highlight its key strengths, and provide you with a roadmap for conquering this challenging but rewarding subject. This post is for anyone from undergraduate students grappling with the material to seasoned mathematicians seeking a refresher or deeper understanding. Whether you're looking for a concise overview or a detailed breakdown of specific chapters, this guide will equip you to effectively utilize Eisenbud's masterpiece. We'll unravel the complexities, highlighting its practical applications and showing you how to master its sophisticated techniques.

## Chapter-by-Chapter Breakdown of Eisenbud's Commutative Algebra

Eisenbud's *Commutative Algebra* is not a casual read; it demands dedication and a strong foundation in abstract algebra. The book's strength lies in its clear exposition of difficult topics, its wealth of examples, and its consistent connection to geometric intuition. However, its breadth can be daunting. Therefore, a structured approach is vital for successful engagement.

### 1. Foundations: Modules and Rings (Chapter 1)

This foundational chapter lays the groundwork for the entire book. Eisenbud expertly builds upon basic ring theory, introducing key concepts like modules, ideals, and quotient rings. He emphasizes the importance of understanding modules as generalizations of vector spaces, a crucial perspective for grasping later chapters. This chapter requires careful attention to detail, as it sets the stage for more advanced material. Pay particular attention to the exercises; they often introduce subtle but important ideas not explicitly stated in the text.

### 1. Noetherian Rings and Modules (Chapter 2):

This chapter introduces the fundamental concept of Noetherian rings and modules – rings

and modules satisfying the ascending chain condition on ideals and submodules, respectively. This seemingly technical condition has profound consequences, enabling powerful techniques like Hilbert's Basis Theorem, which guarantees that polynomial rings over Noetherian rings are also Noetherian. Mastering this chapter is crucial because it underpins many later developments, including discussions of primary decomposition and dimension theory.

### 1. Primary Decomposition and Associated Primes (Chapter 3):

Primary decomposition is a powerful technique for understanding the structure of ideals in Noetherian rings. It essentially provides a way to decompose an ideal into simpler components, analogous to factoring integers into primes. This chapter delves into the concept of associated prime ideals, which reveal vital information about the structure of modules. A firm grasp of this chapter is essential for understanding localization and the subsequent development of dimension theory.

### 1. Localization and Globalization (Chapter 4):

Localization is a transformative technique in commutative algebra. It allows us to "zoom in" on a particular prime ideal within a ring, simplifying the ring's structure while preserving essential information. This chapter skillfully explains the process of localization and its inverse, globalization, highlighting the power of this technique in tackling complex algebraic problems. Understanding localization is essential for a deep comprehension of the remaining chapters.

### 1. Dimension Theory (Chapter 5):

This chapter introduces the crucial concept of Krull dimension, a measure of the "size" of a ring. It elegantly connects algebraic properties with geometric intuition. The various equivalent definitions of dimension are explored, providing a deeper understanding of its multifaceted nature. This chapter is conceptually challenging but rewarding, offering a powerful tool for analyzing the structure of rings and their associated geometric spaces.

### 1. Regular Rings and Local Rings (Chapter 6):

Regular local rings are a particularly well-behaved class of rings that exhibit many desirable properties. This chapter explores the intricate relationships between regularity, dimension, and the properties of the ring's maximal ideal. The concept of a regular sequence is introduced, forming a cornerstone for understanding the depth of modules and rings.

## 1. Modules and Syzygies (Chapter 7):

This chapter delves into the theory of modules and syzygies, focusing on the construction of free resolutions. Free resolutions provide a powerful tool for analyzing the structure of modules and uncovering hidden relationships between them. This chapter often utilizes homological algebra, demanding a solid understanding of exact sequences and related concepts.

## 1. Completions (Chapter 8):

Completion is another powerful technique used in commutative algebra. It allows us to approximate a ring by a simpler structure, often providing valuable insights into its properties. This chapter explores various completion methods and their applications, which are especially valuable in studying local rings and their singularities.

## 1. The Hilbert Syzygy Theorem and Beyond (Chapters 9 & 10):

These concluding chapters delve into the profound Hilbert Syzygy Theorem, showcasing the power of homological techniques in understanding the structure of modules over polynomial rings. This culminates in a discussion of advanced topics, providing a glimpse into more specialized areas of commutative algebra.

# A Concise Outline of Eisenbud's Commutative Algebra

Name: Commutative Algebra with a View Toward Algebraic Geometry

Contents:

Introduction: Setting the stage, outlining the book's objectives and scope.

Part I: Foundations: Rings, modules, ideals, localization, primary decomposition. (Chapters 1-4)

Part II: Dimension Theory: Krull dimension, regular local rings, depth, Cohen-Macaulay rings. (Chapters 5-6)

Part III: Modules and Syzygies: Free resolutions, Hilbert Syzygy Theorem, homological algebra techniques. (Chapters 7-10)

Appendix: Provides supplementary material and background information on specific topics.

## Detailed Explanation of the Outline Sections:

Part I: Foundations: This section establishes the necessary building blocks for understanding the later, more advanced concepts. It begins by introducing fundamental definitions and theorems concerning rings, modules, and ideals. Then, localization is

introduced as a critical tool for simplifying complex rings. Primary decomposition provides a method for understanding the structure of ideals, laying the groundwork for dimension theory.

**Part II: Dimension Theory:** This section introduces the crucial concept of dimension in commutative algebra, linking algebraic properties to geometric intuition. Krull dimension is defined and explored through various equivalent characterizations. Regular local rings, a special class of well-behaved rings, are examined in detail. The concepts of depth and Cohen-Macaulay rings are introduced, providing crucial tools for analyzing the structure of rings and modules.

**Part III: Modules and Syzygies:** This section focuses on the intricate relationship between modules and their free resolutions. Free resolutions, a fundamental concept in homological algebra, provide a systematic way to study the structure of modules. The power of these techniques culminates in a thorough exploration of the Hilbert Syzygy Theorem, a cornerstone result in commutative algebra.

**Appendix:** The appendix serves as a valuable resource, providing supplementary material, background information, and detailed proofs of theorems that may have been omitted in the main text. This ensures that the reader has access to all the necessary information to fully comprehend the content of the book.

## Frequently Asked Questions (FAQs)

1. Is Eisenbud's book suitable for beginners? While comprehensive, it's more suitable for students with a solid foundation in abstract algebra. Beginners might find it challenging without prior exposure to ring theory and module theory.
1. What prerequisites are needed to understand Eisenbud's book? A strong background in abstract algebra, including ring theory and module theory, is essential. Some familiarity with homological algebra is helpful for later chapters.
1. How does Eisenbud's book differ from other commutative algebra textbooks? Eisenbud's book distinguishes itself through its clear exposition, wealth of examples, and consistent connection to geometric intuition. It also covers advanced topics not found in many introductory texts.
1. What are the main strengths of Eisenbud's book? Its clarity, comprehensive coverage, and insightful geometric perspective make it a valuable resource for both students and researchers.

1. What are the main weaknesses of Eisenbud's book? Its breadth can be daunting for beginners, and the pace can be quite demanding.
1. Is there a solutions manual for the exercises in Eisenbud's book? No official solutions manual exists, but many solutions can be found online through various forums and communities.
1. What are some alternative textbooks to Eisenbud's book? Alternatives include Atiyah-MacDonald's Introduction to Commutative Algebra (a more concise introduction) and Matsumura's Commutative Ring Theory (a more advanced text).
1. How long does it typically take to work through Eisenbud's book? The time required depends on the reader's background and pace, but it can easily take a semester or more for a dedicated student.
1. What are the real-world applications of commutative algebra? Commutative algebra has applications in algebraic geometry, number theory, and cryptography. It's a fundamental tool used to understand the structure of algebraic varieties and solve Diophantine equations.

## **Related Articles:**

1. Introduction to Commutative Algebra: A beginner-friendly overview of basic concepts.
2. Module Theory: A Deep Dive: A detailed exploration of module theory, a crucial prerequisite for Eisenbud's book.
3. Ring Theory Fundamentals: A comprehensive guide to ring theory concepts relevant to commutative algebra.
4. Localization in Commutative Algebra: A focused discussion on the technique of localization.
5. Primary Decomposition Explained: A detailed explanation of primary decomposition and its applications.

6. Krull Dimension and its Significance: An in-depth exploration of the concept of Krull dimension.
7. Regular Local Rings: Properties and Examples: A detailed discussion of regular local rings and their properties.
8. Homological Algebra for Commutative Algebra: An introduction to homological algebra techniques used in Eisenbud's book.
9. The Hilbert Syzygy Theorem: Proof and Applications: A comprehensive explanation of this crucial theorem.

**eisenbud commutative algebra: Commutative Algebra** David Eisenbud, 1995-03-30 This is a comprehensive review of commutative algebra, from localization and primary decomposition through dimension theory, homological methods, free resolutions and duality, emphasizing the origins of the ideas and their connections with other parts of mathematics. The book gives a concise treatment of Grobner basis theory and the constructive methods in commutative algebra and algebraic geometry that flow from it. Many exercises included.

**eisenbud commutative algebra: Introduction To Commutative Algebra** Michael F. Atiyah, I.G. MacDonald, 2018-03-09 First Published in 2018. This book grew out of a course of lectures given to third year undergraduates at Oxford University and it has the modest aim of producing a rapid introduction to the subject. It is designed to be read by students who have had a first elementary course in general algebra. On the other hand, it is not intended as a substitute for the more voluminous tracts such as Zariski-Samuel or Bourbaki. We have concentrated on certain central topics, and large areas, such as field theory, are not touched. In content we cover rather more ground than Northcott and our treatment is substantially different in that, following the modern trend, we put more emphasis on modules and localization.

**eisenbud commutative algebra: The Geometry of Schemes** David Eisenbud, Joe Harris, 2006-04-06 Grothendieck's beautiful theory of schemes permeates modern algebraic geometry and underlies its applications to number theory, physics, and applied mathematics. This simple account of that theory emphasizes and explains the universal geometric concepts behind the definitions. In the book, concepts are illustrated with fundamental examples, and explicit calculations show how the constructions of scheme theory are carried out in practice.

**eisenbud commutative algebra: Commutative Algebra** Irena Peeva, 2013-02-01 This contributed volume brings together the highest quality expository papers written by leaders and talented junior mathematicians in the field of Commutative Algebra. Contributions cover a very wide range of topics, including core areas in Commutative Algebra and also relations to Algebraic Geometry, Algebraic Combinatorics, Hyperplane Arrangements, Homological Algebra, and String Theory. The book aims to showcase the area, especially for the benefit of junior mathematicians and researchers who are new to the field; it will aid them in broadening their background and to gain a deeper understanding of the current research in this area. Exciting developments are surveyed and many open problems are discussed with the aspiration to inspire the readers and foster further research.

**eisenbud commutative algebra: Free Resolutions in Commutative Algebra and Algebraic Geometry** Taylor & Francis Group, 2020-09-30 The selected contributions in this volume originated at the Sundance conference, which was devoted to discussions of current work in the area of free resolutions. The papers include new research, not otherwise published, and expositions that develop

current problems likely to influence future developments in the field.

**eisenbud commutative algebra: Undergraduate Commutative Algebra** Miles Reid, 1995-11-30 Commutative algebra is at the crossroads of algebra, number theory and algebraic geometry. This textbook is affordable and clearly illustrated, and is intended for advanced undergraduate or beginning graduate students with some previous experience of rings and fields. Alongside standard algebraic notions such as generators of modules and the ascending chain condition, the book develops in detail the geometric view of a commutative ring as the ring of functions on a space. The starting point is the Nullstellensatz, which provides a close link between the geometry of a variety  $V$  and the algebra of its coordinate ring  $A=k[V]$ ; however, many of the geometric ideas arising from varieties apply also to fairly general rings. The final chapter relates the material of the book to more advanced topics in commutative algebra and algebraic geometry. It includes an account of some famous 'pathological' examples of Akizuki and Nagata, and a brief but thought-provoking essay on the changing position of abstract algebra in today's world.

**eisenbud commutative algebra: The Geometry of Syzygies** David Eisenbud, 2006-10-28 First textbook-level account of basic examples and techniques in this area. Suitable for self-study by a reader who knows a little commutative algebra and algebraic geometry already. David Eisenbud is a well-known mathematician and current president of the American Mathematical Society, as well as a successful Springer author.

**eisenbud commutative algebra: Algebraic Geometry** Robin Hartshorne, 2013-06-29 An introduction to abstract algebraic geometry, with the only prerequisites being results from commutative algebra, which are stated as needed, and some elementary topology. More than 400 exercises distributed throughout the book offer specific examples as well as more specialised topics not treated in the main text, while three appendices present brief accounts of some areas of current research. This book can thus be used as textbook for an introductory course in algebraic geometry following a basic graduate course in algebra. Robin Hartshorne studied algebraic geometry with Oscar Zariski and David Mumford at Harvard, and with J.-P. Serre and A. Grothendieck in Paris. He is the author of Residues and Duality, Foundations of Projective Geometry, Ample Subvarieties of Algebraic Varieties, and numerous research titles.

**eisenbud commutative algebra: Basic Commutative Algebra** Balwant Singh, 2011 This textbook, set for a one or two semester course in commutative algebra, provides an introduction to commutative algebra at the postgraduate and research levels. The main prerequisites are familiarity with groups, rings and fields. Proofs are self-contained. The book will be useful to beginners and experienced researchers alike. The material is so arranged that the beginner can learn through self-study or by attending a course. For the experienced researcher, the book may serve to present new perspectives on some well-known results, or as a reference.

**eisenbud commutative algebra: Commutative Algebra** Irena Peeva, 2022-02-20 This contributed volume is a follow-up to the 2013 volume of the same title, published in honor of noted Algebraist David Eisenbud's 65th birthday. It brings together the highest quality expository papers written by leaders and talented junior mathematicians in the field of Commutative Algebra. Contributions cover a very wide range of topics, including core areas in Commutative Algebra and also relations to Algebraic Geometry, Category Theory, Combinatorics, Computational Algebra, Homological Algebra, Hyperplane Arrangements, and Non-commutative Algebra. The book aims to showcase the area and aid junior mathematicians and researchers who are new to the field in broadening their background and gaining a deeper understanding of the current research in this area. Exciting developments are surveyed and many open problems are discussed with the aspiration to inspire the readers and foster further research.

**eisenbud commutative algebra: Commutative Ring Theory** Hideyuki Matsumura, 1989-05-25 This book explores commutative ring theory, an important foundation for algebraic geometry and complex analytical geometry.

**eisenbud commutative algebra: Local Algebra** Jean-Pierre Serre, 2012-12-06 This is an English translation of the now classic *Algebre Locale - Multiplicités* originally published by Springer as

LNM 11. It gives a short account of the main theorems of commutative algebra, with emphasis on modules, homological methods and intersection multiplicities. Many modifications to the original French text have been made for this English edition, making the text easier to read, without changing its intended informal character.

**eisenbud commutative algebra:** *Commutative Algebra* Irena Peeva, 2022-02-18 This contributed volume is a follow-up to the 2013 volume of the same title, published in honor of noted Algebraist David Eisenbud's 65th birthday. It brings together the highest quality expository papers written by leaders and talented junior mathematicians in the field of Commutative Algebra. Contributions cover a very wide range of topics, including core areas in Commutative Algebra and also relations to Algebraic Geometry, Category Theory, Combinatorics, Computational Algebra, Homological Algebra, Hyperplane Arrangements, and Non-commutative Algebra. The book aims to showcase the area and aid junior mathematicians and researchers who are new to the field in broadening their background and gaining a deeper understanding of the current research in this area. Exciting developments are surveyed and many open problems are discussed with the aspiration to inspire the readers and foster further research.

**eisenbud commutative algebra:** *Algebraic Geometry* Ulrich Görtz, Torsten Wedhorn, 2010-08-06 This book introduces the reader to modern algebraic geometry. It presents Grothendieck's technically demanding language of schemes that is the basis of the most important developments in the last fifty years within this area. A systematic treatment and motivation of the theory is emphasized, using concrete examples to illustrate its usefulness. Several examples from the realm of Hilbert modular surfaces and of determinantal varieties are used methodically to discuss the covered techniques. Thus the reader experiences that the further development of the theory yields an ever better understanding of these fascinating objects. The text is complemented by many exercises that serve to check the comprehension of the text, treat further examples, or give an outlook on further results. The volume at hand is an introduction to schemes. To get started, it requires only basic knowledge in abstract algebra and topology. Essential facts from commutative algebra are assembled in an appendix. It will be complemented by a second volume on the cohomology of schemes.

**eisenbud commutative algebra:** *Computational Methods in Commutative Algebra and Algebraic Geometry* Wolmer Vasconcelos, 2004-05-18 This ACM volume deals with tackling problems that can be represented by data structures which are essentially matrices with polynomial entries, mediated by the disciplines of commutative algebra and algebraic geometry. The discoveries stem from an interdisciplinary branch of research which has been growing steadily over the past decade. The author covers a wide range, from showing how to obtain deep heuristics in a computation of a ring, a module or a morphism, to developing means of solving nonlinear systems of equations - highlighting the use of advanced techniques to bring down the cost of computation. Although intended for advanced students and researchers with interests both in algebra and computation, many parts may be read by anyone with a basic abstract algebra course.

**eisenbud commutative algebra:** *Introduction to Commutative Algebra and Algebraic Geometry* Ernst Kunz, 2012-11-06 Originally published in 1985, this classic textbook is an English translation of *Einführung in die kommutative Algebra und algebraische Geometrie*. As part of the Modern Birkhäuser Classics series, the publisher is proud to make *Introduction to Commutative Algebra and Algebraic Geometry* available to a wider audience. Aimed at students who have taken a basic course in algebra, the goal of the text is to present important results concerning the representation of algebraic varieties as intersections of the least possible number of hypersurfaces and—a closely related problem—with the most economical generation of ideals in Noetherian rings. Along the way, one encounters many basic concepts of commutative algebra and algebraic geometry and proves many facts which can then serve as a basic stock for a deeper study of these subjects.

**eisenbud commutative algebra:** *Computations in Algebraic Geometry with Macaulay 2* David Eisenbud, Daniel R. Grayson, Mike Stillman, Bernd Sturmfels, 2001-09-25 This book presents algorithmic tools for algebraic geometry, with experimental applications. It also introduces

Macaulay 2, a computer algebra system supporting research in algebraic geometry, commutative algebra, and their applications. The algorithmic tools presented here are designed to serve readers wishing to bring such tools to bear on their own problems. The first part of the book covers Macaulay 2 using concrete applications; the second emphasizes details of the mathematics.

**eisenbud commutative algebra:** Combinatorial Aspects of Commutative Algebra and Algebraic Geometry Gunnar Fløystad, Trygve Johnsen, Andreas Leopold Knutsen, 2011-05-16 The Abel Symposium 2009 Combinatorial aspects of Commutative Algebra and Algebraic Geometry, held at Voss, Norway, featured talks by leading researchers in the field. This is the proceedings of the Symposium, presenting contributions on syzygies, tropical geometry, Boij-Söderberg theory, Schubert calculus, and quiver varieties. The volume also includes an introductory survey on binomial ideals with applications to hypergeometric series, combinatorial games and chemical reactions. The contributions pose interesting problems, and offer up-to-date research on some of the most active fields of commutative algebra and algebraic geometry with a combinatorial flavour.

**eisenbud commutative algebra:** Trends in Commutative Algebra Luchezar L. Avramov, Mark Green, Craig Huneke, Karen E. Smith, Bernd Sturmfels, 2004-12-13 This book describes the interaction of commutative algebra with other areas of mathematics, including algebraic geometry, group cohomology, and combinatorics.

**eisenbud commutative algebra:** Commutative Algebra and Noncommutative Algebraic Geometry David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford, Michel Van den Bergh, 2015-11-19 This book surveys fundamental current topics in these two areas of research, emphasising the lively interaction between them. Volume 2 focuses on the most recent research.

**eisenbud commutative algebra:** *Computational Commutative Algebra 1* Martin Kreuzer, Lorenzo Robbiano, 2008-07-15 This introduction to polynomial rings, Gröbner bases and applications bridges the gap in the literature between theory and actual computation. It details numerous applications, covering fields as disparate as algebraic geometry and financial markets. To aid in a full understanding of these applications, more than 40 tutorials illustrate how the theory can be used. The book also includes many exercises, both theoretical and practical.

**eisenbud commutative algebra:** **3264 and All That** David Eisenbud, Joe Harris, 2016-04-14 3264, the mathematical solution to a question concerning geometric figures.

**eisenbud commutative algebra:** **Steps in Commutative Algebra** R. Y. Sharp, 2000 Introductory account of commutative algebra, aimed at students with a background in basic algebra.

**eisenbud commutative algebra:** *Combinatorial Commutative Algebra* Ezra Miller, Bernd Sturmfels, 2005-06-21 Recent developments are covered Contains over 100 figures and 250 exercises Includes complete proofs

**eisenbud commutative algebra:** *A Term of Commutative Algebra* Steven Kleiman, Allen Altman, 2013-01-01 There is no shortage of books on Commutative Algebra, but the present book is different. Most books are monographs, with extensive coverage. There is one notable exception: Atiyah and Macdonald's 1969 classic. It is a clear, concise, and efficient textbook, aimed at beginners, with a good selection of topics. So it has remained popular. However, its age and flaws do show. So there is need for an updated and improved version, which the present book aims to be.

**eisenbud commutative algebra:** Commutative Algebra and Noncommutative Algebraic Geometry David Eisenbud, Srikanth B. Iyengar, Anurag K. Singh, J. Toby Stafford, Michel Van den Bergh, 2015-11-19 This book surveys fundamental current topics in these two areas of research, emphasising the lively interaction between them. Volume 1 contains expository papers ideal for those entering the field.

**eisenbud commutative algebra:** *History Algebraic Geometry* Jean Dieudonné, 1985-05-30 This book contains several fundamental ideas that are revived time after time in different guises, providing a better understanding of algebraic geometric phenomena. It shows how the field is enriched with loans from analysis and topology and from commutative algebra and homological algebra.

**eisenbud commutative algebra:** *Algebra: Chapter 0* Paolo Aluffi, 2021-11-09 Algebra: Chapter

0 is a self-contained introduction to the main topics of algebra, suitable for a first sequence on the subject at the beginning graduate or upper undergraduate level. The primary distinguishing feature of the book, compared to standard textbooks in algebra, is the early introduction of categories, used as a unifying theme in the presentation of the main topics. A second feature consists of an emphasis on homological algebra: basic notions on complexes are presented as soon as modules have been introduced, and an extensive last chapter on homological algebra can form the basis for a follow-up introductory course on the subject. Approximately 1,000 exercises both provide adequate practice to consolidate the understanding of the main body of the text and offer the opportunity to explore many other topics, including applications to number theory and algebraic geometry. This will allow instructors to adapt the textbook to their specific choice of topics and provide the independent reader with a richer exposure to algebra. Many exercises include substantial hints, and navigation of the topics is facilitated by an extensive index and by hundreds of cross-references.

**eisenbud commutative algebra:** Undergraduate Algebraic Geometry Miles Reid, Miles A. Reid, 1988-12-15 Algebraic geometry is, essentially, the study of the solution of equations and occupies a central position in pure mathematics. This short and readable introduction to algebraic geometry will be ideal for all undergraduate mathematicians coming to the subject for the first time. With the minimum of prerequisites, Dr Reid introduces the reader to the basic concepts of algebraic geometry including: plane conics, cubics and the group law, affine and projective varieties, and non-singularity and dimension. He is at pains to stress the connections the subject has with commutative algebra as well as its relation to topology, differential geometry, and number theory. The book arises from an undergraduate course given at the University of Warwick and contains numerous examples and exercises illustrating the theory.

**eisenbud commutative algebra:** Algebraic Geometry, Arcata 1974 Robin Hartshorne, American Mathematical Society, 1975-12-31

**eisenbud commutative algebra:** *Graded Syzygies* Irena Peeva, 2010-11-29 The study of free resolutions is a core and beautiful area in Commutative Algebra. The main goal of this book is to inspire the readers and develop their intuition about syzygies and Hilbert functions. Many examples are given in order to illustrate ideas and key concepts. A valuable feature of the book is the inclusion of open problems and conjectures; these provide a glimpse of exciting, and often challenging, research directions in the field. Three types of problems are presented: Conjectures, Problems, and Open-Ended Problems. The latter do not describe specific problems but point to interesting directions for exploration. The first part of the monograph contains basic background material on graded free resolutions. Further coverage of topics includes syzygies over a polynomial ring, resolutions over quotient rings, lex ideals and Hilbert functions, compression, resolutions of monomial ideals, and syzygies of toric ideals. With a clear and self-contained exposition this text is intended for advanced graduate students and postdoctorates; it will be also of interest to senior mathematicians.

**eisenbud commutative algebra:** Algebraic Geometry and Commutative Algebra Siegfried Bosch, 2022-04-22 Algebraic Geometry is a fascinating branch of Mathematics that combines methods from both Algebra and Geometry. It transcends the limited scope of pure Algebra by means of geometric construction principles. Putting forward this idea, Grothendieck revolutionized Algebraic Geometry in the late 1950s by inventing schemes. Schemes now also play an important role in Algebraic Number Theory, a field that used to be far away from Geometry. The new point of view paved the way for spectacular progress, such as the proof of Fermat's Last Theorem by Wiles and Taylor. This book explains the scheme-theoretic approach to Algebraic Geometry for non-experts, while more advanced readers can use it to broaden their view on the subject. A separate part presents the necessary prerequisites from Commutative Algebra, thereby providing an accessible and self-contained introduction to advanced Algebraic Geometry. Every chapter of the book is preceded by a motivating introduction with an informal discussion of its contents and background. Typical examples, and an abundance of exercises illustrate each section. Therefore the book is an excellent companion for self-studying or for complementing skills that have already been

acquired. It can just as well serve as a convenient source for (reading) course material and, in any case, as supplementary literature. The present edition is a critical revision of the earlier text.

**eisenbud commutative algebra: A Singular Introduction to Commutative Algebra**

Gert-Martin Greuel, Gerhard Pfister, 2012-12-06 This book can be understood as a model for teaching commutative algebra, and takes into account modern developments such as algorithmic and computational aspects. As soon as a new concept is introduced, the authors show how the concept can be worked on using a computer. The computations are exemplified with the computer algebra system Singular, developed by the authors. Singular is a special system for polynomial computation with many features for global as well as for local commutative algebra and algebraic geometry. The book includes a CD containing Singular as well as the examples and procedures explained in the book.

**eisenbud commutative algebra: Grobner Bases in Commutative Algebra**

Viviana Ene, Jürgen Herzog, 2011-12-01 This book provides a concise yet comprehensive and self-contained introduction to Grobner basis theory and its applications to various current research topics in commutative algebra. It especially aims to help young researchers become acquainted with fundamental tools and techniques related to Grobner bases which are used in commutative algebra and to arouse their interest in exploring further topics such as toric rings, Koszul and Rees algebras, determinantal ideal theory, binomial edge ideals, and their applications to statistics. The book can be used for graduate courses and self-study. More than 100 problems will help the readers to better understand the main theoretical results and will inspire them to further investigate the topics studied in this book.

**eisenbud commutative algebra: Algebraic Geometry and Arithmetic Curves**

Qing Liu, Reinie Erne, 2006-06-29 This book is a general introduction to the theory of schemes, followed by applications to arithmetic surfaces and to the theory of reduction of algebraic curves. The first part introduces basic objects such as schemes, morphisms, base change, local properties (normality, regularity, Zariski's Main Theorem). This is followed by the more global aspect: coherent sheaves and a finiteness theorem for their cohomology groups. Then follows a chapter on sheaves of differentials, dualizing sheaves, and Grothendieck's duality theory. The first part ends with the theorem of Riemann-Roch and its application to the study of smooth projective curves over a field. Singular curves are treated through a detailed study of the Picard group. The second part starts with blowing-ups and desingularisation (embedded or not) of fibered surfaces over a Dedekind ring that leads on to intersection theory on arithmetic surfaces. Castelnuovo's criterion is proved and also the existence of the minimal regular model. This leads to the study of reduction of algebraic curves. The case of elliptic curves is studied in detail. The book concludes with the fundamental theorem of stable reduction of Deligne-Mumford. The book is essentially self-contained, including the necessary material on commutative algebra. The prerequisites are therefore few, and the book should suit a graduate student. It contains many examples and nearly 600 exercises.

**eisenbud commutative algebra: Galois Theories**

Francis Borceux, George Janelidze, 2001-02-22 Starting from the classical finite-dimensional Galois theory of fields, this book develops Galois theory in a much more general context, presenting work by Grothendieck in terms of separable algebras and then proceeding to the infinite-dimensional case, which requires considering topological Galois groups. In the core of the book, the authors first formalize the categorical context in which a general Galois theorem holds, and then give applications to Galois theory for commutative rings, central extensions of groups, the topological theory of covering maps and a Galois theorem for toposes. The book is designed to be accessible to a wide audience: the prerequisites are first courses in algebra and general topology, together with some familiarity with the categorical notions of limit and adjoint functors. The first chapters are accessible to advanced undergraduates, with later ones at a graduate level. For all algebraists and category theorists this book will be a rewarding read.

**eisenbud commutative algebra: Commutative Algebra, Algebraic Geometry, and**

**Computational Methods** David Eisenbud, 1999-07 This volume contains papers presented at the International Conference on Commutative Algebra, Algebraic geometry, and Computational methods

held in Hanoi in 1996, as well as papers written subsequently. It features both expository articles as well as research papers on a range of currently active areas in commutative algebra, algebraic geometry (particularly surveys on intersection theory) and combinatorics. In addition, a special feature is a section on the life and work of Wolfgang Vogel, who was an organiser of the conference.

**eisenbud commutative algebra: Commutative Algebra With A View Toward Alg** David Eisenbud, 1995 Commutative Algebra is best understood with knowledge of the geometric ideas that have played a great role in its formation, in short, with a view towards algebraic geometry. The author presents a comprehensive view of commutative algebra, from basics, such as localization and primary decomposition, through dimension theory, differentials, homological methods, free resolutions and duality, emphasizing the origins of the ideas and their connections with other parts of mathematics. Many exercises illustrate and sharpen the theory and extended exercises give the reader an active part in complementing the material presented in the text. One novel feature is a chapter devoted to a quick but thorough treatment of Grobner basis theory and the constructive methods in commutative algebra and algebraic geometry that flow from it. Applications of the theory and even suggestions for computer algebra projects are included. This book will appeal to readers from beginners to advanced students of commutative algebra or algebraic geometry. To help beginners, the essential ideals from algebraic geometry are treated from scratch. Appendices on homological algebra, multilinear algebra and several other useful topics help to make the book relatively self-contained. Novel results and presentations are scattered throughout the text.

**eisenbud commutative algebra: Commutative Algebra** Melvin Hochster, Craig Huneke, Judith D. Sally, 2012-12-06 During late June and early July of 1987 a three week program (dubbed microprogram) in Commutative Algebra was held at the Mathematical Sciences Research Institute at Berkeley. The intent of the microprogram was to survey recent major results and current trends in the theory of commutative rings, especially commutative Noetherian rings. There was enthusiastic international participation. The papers in this volume, some of which are expository, some strictly research, and some a combination, reflect the intent of the program. They give a cross-section of what is happening now in this area. Nearly all of the manuscripts were solicited from the speakers at the conference, and in most instances the manuscript is based on the conference lecture. The editors hope that they will be of interest and of use both to experts and neophytes in the field. The editors would like to express their appreciation to the director of MSRI, Professor Irving Kaplansky, who first suggested the possibility of such a conference and made the task of organization painless. We would also like to thank the IVISRI staff who were unfailingly efficient, pleasant, and helpful during the meeting, and the manager of MSRI, Arlene Baxter, for her help with this volume. Finally we would like to express our appreciation to David Mostardi who did much of the typing and put the electronic pieces together.

**eisenbud commutative algebra: An Invitation to Algebraic Geometry** Karen E. Smith, Lauri Kahanpää, Pekka Kekäläinen, William Traves, 2013-03-09 This is a description of the underlying principles of algebraic geometry, some of its important developments in the twentieth century, and some of the problems that occupy its practitioners today. It is intended for the working or the aspiring mathematician who is unfamiliar with algebraic geometry but wishes to gain an appreciation of its foundations and its goals with a minimum of prerequisites. Few algebraic prerequisites are presumed beyond a basic course in linear algebra.

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