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Curves and Their Applications Applications of Algebraic Geometry to Coding Theory, Physics and Computation Differential Geometry of Curves and Surfaces A Guide to Plane Algebraic Curves Elementary Geometry of Algebraic Curves Tate's Linear Algebra and Residues on Curves The Moduli Space of Curves Algebraic Curves Monopoles, Minimal Surfaces and Algebraic Curves Arithmetic of Algebraic Curves Topology of Algebraic Curves Practical Handbook of Curve Design and Generation Algebraic Geometry

By virtue of their special algebraic structures, Pythagorean-hodograph (PH) curves offer unique advantages for computer-aided design and manufacturing, robotics, motion control, path planning, computer graphics, animation, and related fields. This book offers a comprehensive and self-contained treatment of the mathematical theory of PH curves, including algorithms for their construction and examples of their practical applications. It emphasizes the interplay of ideas from algebra and geometry and their historical origins and includes many figures, worked examples, and detailed algorithm descriptions. Plane Algebraic Curves is a classroom-tested textbook for advanced undergraduate and beginning graduate students in mathematics. The book introduces the *contemporary notions of algebraic varieties, morphisms of varieties, and adeles to the classical subject of plane curves over algebraically closed fields. By restricting the rigorous development of these notions to a traditional context the book makes its subject accessible without extensive algebraic prerequisites. Once the reader's intuition for plane curves has evolved, there is a discussion of how these objects can be generalized to higher dimensional settings. These features, as well as a proof of the Riemann-Roch Theorem based on a combination of geometric and algebraic considerations, make the book a good foundation for more specialized study in algebraic geometry, commutative algebra, and algebraic function fields. Plane Algebraic Curves is suitable for readers with a variety of backgrounds and interests. The book begins with a chapter outlining prerequisites, and contains informal discussions giving an overview of its material and relating it to non-algebraic topics which would be familiar to the general reader. There is an explanation of why the algebraic genus of a hyperelliptic curve agrees with its geometric genus as a compact Riemann surface, as well as a thorough description of how the classically important elliptic curves can be described in various normal forms. The book* *concludes with a bibliography which students can incorporate into their further studies. Book jacket. This development of the theory of complex algebraic curves was one of the peaks of nineteenth century mathematics. They have many fascinating properties and arise in various areas of mathematics, from number theory to theoretical physics, and are the subject of much research. By using only the basic techniques acquired in most undergraduate courses in mathematics, Dr. Kirwan introduces the theory, observes the algebraic and topological properties of complex algebraic curves, and shows how they are related to complex analysis. The book was easy to understand, with many examples. The exercises were well chosen, and served to give further examples and developments of the theory. --William Goldman, University of Maryland In this book, Miranda takes the approach that algebraic curves are best encountered for the first time over the complex numbers, where the reader's classical intuition about surfaces, integration, and other concepts can be brought into play. Therefore, many examples of algebraic curves are presented in the first chapters. In this way, the book begins as a primer on Riemann surfaces, with complex charts and meromorphic functions taking center stage. But the main* *examples come from projective curves, and slowly but surely the text moves toward the algebraic category. Proofs of the Riemann-Roch and Serre Duality Theorems are presented in an algebraic manner, via an adaptation of the adelic proof, expressed completely in terms of solving a Mittag-Leffler problem. Sheaves and cohomology are introduced as a unifying device in the latter chapters, so that their utility and naturalness are immediately obvious. Requiring a background of one semester of complex variable theory and a year of abstract algebra, this is an excellent graduate textbook for a second-semester course in complex variables or a year-long course in algebraic geometry. This book was written to furnish a starting point for the study of algebraic geometry. The topics presented and methods of presenting them were chosen with the following ideas in mind; to keep the treat ment as elementary as possible, to introduce some of the recently devel oped algebraic methods of handling problems of algebraic geometry, to show how these methods are related to the older analytic and geometric methods, and to apply the general methods to specific geometric prob lems. These criteria led to a selection of topics from the theory of curves, centering around birational transformations and linear series. Experience* *in teaching the material showed the need of an intro duction to the underlying algebra and projective geometry, so this is supplied in the first two chapters. The inclusion of this material makes the book almost entirely self-contained. Methods of presentation, proof of theorems, and problems, have been adapted from various sources. We should mention, in particular, Severi-Laffier, Vorlesungen uber Algebraische Geometrie, van der Waerden, Algebraische Geometrie and Moderne Algebra, and lecture notes of S. Lefschetz and O. Zariski. We also wish to thank Mr. R. L. Beinert and Prof. G. L. Walker for suggestions and assistance with the proof, and particularly Prof. Saunders MacLane for a very careful examination and criticism of an early version of the work. R. J. WALKER Cornell University December 1, 1949 Contents Preface . This volume contains a collection of papers on algebraic curves and their applications. While algebraic curves traditionally have provided a path toward modern algebraic geometry, they also provide many applications in number theory, computer security and cryptography, coding theory, differential equations, and more. Papers cover topics such as the rational torsion points of elliptic curves, arithmetic statistics in the moduli space of curves, combinatorial descriptions of semistable* *hyperelliptic curves over local fields, heights on weighted projective spaces, automorphism groups of curves, hyperelliptic curves, dessins d'enfants, applications to Painlevé equations, descent on real algebraic varieties, quadratic residue codes based on hyperelliptic curves, and Abelian varieties and cryptography. This book will be a valuable resource for people interested in algebraic curves and their connections to other branches of mathematics. Author S.A. Stepanov thoroughly investigates the current state of the theory of Diophantine equations and its related methods. Discussions focus on arithmetic, algebraic-geometric, and logical aspects of the problem. Designed for students as well as researchers, the book includes over 250 excercises accompanied by hints, instructions, and references. Written in a clear manner, this text does not require readers to have special knowledge of modern methods of algebraic geometry. Computers are now being used virtually everywhere in arts, drafting, and design to generate curves and surfaces ranging from the elementary to the intricate. Practical Handbook of Curve Design and Generation is a ready reference that presents the basic mathematics of curves in a complete, clear manner that enables you to apply the material to your own work with* *minimum effort. By knowing how curves are mathematically generated and how their shape is controlled, you can more fully exploit available computer tools, modify these tools themselves, and provide input for others to modify them. It will also help you to identify mathematical equations required to produce specific curves. The book does not require a heavy mathematical background-if you understand elementary algebra and trigonometry, you can fully apply the material presented. Essential mathematical concepts are repeated in the book to reinforce your knowledge of those topics. Featuring some 300 graphic examples, the book is organized so that early chapters cover fundamental polynomial, trigonometric, and exponential forms. The mathematical transformation of curves is then treated in order to give you a general approach for modifying known curves. Later chapters introduce complex curves that can be composed from the building blocks presented in earlier chapters. The final chapters cover interesting ideas in space curves and in surfaces. This is a graduate-level text on algebraic geometry that provides a quick and fully self-contained development of the fundamentals, including all commutative algebra which is used. A taste of the deeper theory is given: some topics, such as local* algebra and ramification theory, are treated in depth. The book culminates with a selection of topics from the theory of algebraic curves, including the Riemann-Roch theorem, elliptic curves, the zeta function of a curve over a finite field, and the Riemann hypothesis for elliptic curves. Algebraic curves are the graphs of polynomial equations in two vari 3 ables, such as y3 + 5xy2 = x + 2xy. By focusing on curves of degree at most 3-lines, conics, and cubics-this book aims to fill the gap between the familiar subject of analytic geometry and the general study of alge braic curves. This text is designed for a one-semester class that serves both as a a geometry course for mathematics majors in general and as a sequel to college geometry for teachers of secondary school mathe matics. The only prerequisite is first-year calculus. On the one hand, this book can serve as a text for an undergraduate geometry course for all mathematics majors. Algebraic geometry unites algebra, geometry, topology, and analysis, and it is one of the most exciting areas of modem mathematics. Unfortunately, the subject is not easily accessible, and most introductory courses require a prohibitive amount of mathematical machinery. We avoid this problem by focusing on curves of degree at most 3. This keeps the results tangible and the proofs *natural. It lets us emphasize the power of two fundamental ideas, homogeneous coordinates and intersection multiplicities. This book covers the beautiful theory of resolutions of surface singularities in characteristic zero. The primary goal is to present in detail, and for the first time in one volume, two proofs for the existence of such resolutions. One construction was introduced by H.W.E. Jung, and another is due to O. Zariski. Jung's approach uses quasi-ordinary singularities and an explicit study of specific surfaces in affine three-space. In particular, a new proof of the Jung-Abhyankar theorem is given via ramification theory. Zariski's method, as presented, involves repeated normalisation and blowing up points. It also uses the uniformization of zero-dimensional valuations of function fields in two variables, for which a complete proof is given. Despite the intention to serve graduate students and researchers of Commutative Algebra and Algebraic Geometry, a basic knowledge on these topics is necessary only. This is obtained by a thorough introduction of the needed algebraic tools in the two appendices. 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 funadmental 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. The book summarizes the state and new results on the topology of* *trigonal curves in geometrically ruled surfaces. Emphasis is placed upon various applications of the theory to related areas, most notably singular plane curves of small degree, elliptic surfaces, and Lefschetz fibrations (both complex and real), and Hurwitz equivalence of braid monodromy factorizations. The monograph conveys recent knowledge about related objects and is of interest to researchers and graduate students in the fields of topology and of complex and real algebraic varieties. Elliptic Tales describes the latest developments in number theory by looking at one of the most exciting unsolved problems in contemporary mathematics--the Birch and Swinnerton-Dyer Conjecture. The Clay Mathematics Institute is offering a prize of $1 million to anyone who can discover a general solution to the problem. The key to the conjecture lies in elliptic curves, which are cubic equations in two variables. These equations may appear simple, yet they arise from some very deep--and often very mystifying--mathematical ideas. Using only basic algebra and calculus while presenting numerous eye-opening examples, Ash and Gross make these ideas accessible to general readers, and, in the process, venture to the very frontiers of modern mathematics. Along the way, they give* *an informative and entertaining introduction to some of the most profoundmay appear simple, yet they arise from some very deep--and often very mystifying--mathematical ideas. Using only basic algebra and calculus while presenting numerous eye-opening examples, Ash and Gross make these ideas accessible to general readers, and, in the process, venture to the very frontiers of modern mathematics. Along the way, they give an informative and entertaining introduction to some of the most profound discoveries of the last three centuries in algebraic geometry, abstract algebra, and number theory. They demonstrate how mathematics grows more abstract to tackle ever more challenging problems, and how each new generation of mathematicians builds on the accomplishments of those who preceded them. Ash and Gross fully explain how the Birch and Swinnerton-Dyer Conjecture sheds light on the number theory of elliptic curves, and how it provides a beautiful and startling connection between two very different objects arising from an elliptic curve, one based on calculus, the other on algebra. Capacity is a measure of size for sets, with diverse applications in potential theory, probability and number theory. This book lays foundations for a theory of capacity for adelic sets on algebraic curves. Its main result is an* *arithmetic one, a generalization of a theorem of Fekete and Szegö which gives a sharp existence/finiteness criterion for algebraic points whose conjugates lie near a specified set on a curve. The book brings out a deep connection between the classical Green's functions of analysis and Néron's local height pairings; it also points to an interpretation of capacity as a kind of intersection index in the framework of Arakelov Theory. It is a research monograph and will primarily be of interest to number theorists and algebraic geometers; because of applications of the theory, it may also be of interest to logicians. The theory presented generalizes one due to David Cantor for the projective line. As with most adelic theories, it has a local and a global part. Let /K be a smooth, complete curve over a global field; let Kv denote the algebraic closure of any completion of K. The book first develops capacity theory over local fields, defining analogues of the classical logarithmic capacity and Green's functions for sets in (Kv). It then develops a global theory, defining the capacity of a galois-stable set in (Kv) relative to an effictive global algebraic divisor. The main technical result is the construction of global algebraic functions whose logarithms closely approximate Green's functions at all places of*

K. These functions are used in proving the generalized Fekete-Szegö theorem; because of their mapping properties, they may be expected to have other applications as well. One of the most widely used texts in its field, this volume introduces the differential geometry of curves and surfaces in both local and global aspects. The presentation departs from the traditional approach with its more extensive use of elementary linear algebra and its emphasis on basic geometrical facts rather than machinery or random details. Many examples and exercises enhance the clear, well-written exposition, along with hints and answers to some of the problems. The treatment begins with a chapter on curves, followed by explorations of regular surfaces, the geometry of the Gauss map, the intrinsic geometry of surfaces, and global differential geometry. Suitable for advanced undergraduates and graduate students of mathematics, this text's prerequisites include an undergraduate course in linear algebra and some familiarity with the calculus of several variables. For this second edition, the author has corrected, revised, and updated the entire volume. Here is an introduction to plane algebraic curves from a geometric viewpoint, designed as a first text for undergraduates in mathematics, or for postgraduate and research workers in *the engineering and physical sciences. The book is well illustrated and contains several hundred worked examples and exercises. From the familiar lines and conics of elementary geometry the reader proceeds to general curves in the real affine plane, with excursions to more general fields to illustrate applications, such as number theory. By adding points at infinity the affine plane is extended to the projective plane, yielding a natural setting for curves and providing a flood of illumination into the underlying geometry. A minimal amount of algebra leads to the famous theorem of Bezout, while the ideas of linear systems are used to discuss the classical group structure on the cubic. These lectures, delivered by Professor Mumford at Harvard in 1963-1964, are devoted to a study of properties of families of algebraic curves, on a non-singular projective algebraic curve defined over an algebraically closed field of arbitrary characteristic. The methods and techniques of Grothendieck, which have so changed the character of algebraic geometry in recent years, are used systematically throughout. Thus the classical material is presented from a new viewpoint. * Employs proven conception of teaching topics in commutative algebra through a focus on their applications to algebraic geometry, a* *significant departure from other works on plane algebraic curves in which the topological-analytic aspects are stressed *Requires only a basic knowledge of algebra, with all necessary algebraic facts collected into several appendices * Studies algebraic curves over an algebraically closed field K and those of prime characteristic, which can be applied to coding theory and cryptography * Covers filtered algebras, the associated graded rings and Rees rings to deduce basic facts about intersection theory of plane curves, applications of which are standard tools of computer algebra * Examples, exercises, figures and suggestions for further study round out this fairly self-contained textbook This book differs from a number of recent books on this subject in that it combines analytic and geometric methods at the outset, so that the reader can grasp the basic results of the subject. Although such modern techniques of sheaf theory, cohomology, and commutative algebra are not covered here, the book provides a solid foundation to proceed to more advanced texts in general algebraic geometry, complex manifolds, and Riemann surfaces, as well as algebraic curves. Containing numerous exercises this book would make an excellent introductory text. Let X be a projective smooth curve over an* *algebraically closed field k. Let K = k(X) the field of rational functions on X and O_X,p the regular local ring on p, for p in X. Since X is smooth and dim X = 1, the completion of the regular local ring in p is isomorphic to ring of power series in one variable t, for t a choice of uniformizing parameter in p. Then K_p, is isomorphic to the ring of Laurent series in one variable t. In this situation, just as in complex analysis, one could define for a differential fdg, f,g in K_p, the residue in p to be the coefficient of t^-1 in the Laurent expansion of f(t)g'(t). However, it is not obvious that such coefficient is independent of the choice of uniformizing parameter t. In his article, Residues of differentials on curves, John Tate gave a free-coordinate approach to residues. In this document we explore the concept of Tate vector spaces, topological vector spaces that abstract topological properties of k((t)). This is done in order to understand Tate's construction in terms of topological properties. In this way it is shown the invariance of the residue formula and the residue theorem. This book had its origins in the NATO Advanced Study Institute (ASI) held in Ohrid, Macedonia, in 2014. The focus of this ASI was the arithmetic of superelliptic curves and their application in different* *scientific areas, including whether all the applications of hyperelliptic curves, such as cryptography, mathematical physics, quantum computation and diophantine geometry, can be carried over to the superelliptic curves. Additional papers have been added which provide some background for readers who were not at the conference, with the intention of making the book logically more complete and easier to read, but familiarity with the basic facts of algebraic geometry, commutative algebra and number theory are assumed. The book is divided into three sections. The first part deals with superelliptic curves with regard to complex numbers, the automorphisms group and the corresponding Hurwitz loci. The second part of the book focuses on the arithmetic of the subject, while the third addresses some of the applications of superelliptic curves. The aim of these notes is to develop the theory of algebraic curves from the viewpoint of modern algebraic geometry, but without excessive prerequisites. We have assumed that the reader is familiar with some basic properties of rings, ideals and polynomials, such as is often covered in a one-semester course in modern algebra; additional commutative algebra is developed in later sections. This is an excellent introduction to algebraic geometry, which* *assumes only standard undergraduate mathematical topics: complex analysis, rings and fields, and topology. Reading this book will help establish the geometric intuition that lies behind the more advanced ideas and techniques used in the study of higher-dimensional varieties. The theory relating algebraic curves and Riemann surfaces exhibits the unity of mathematics: topology, complex analysis, algebra and geometry all interact in a deep way. This textbook offers an elementary introduction to this beautiful theory for an undergraduate audience. At the heart of the subject is the theory of elliptic functions and elliptic curves. A complex torus (or "donut") is both an abelian group and a Riemann surface. It is obtained by identifying points on the complex plane. At the same time, it can be viewed as a complex algebraic curve, with addition of points given by a geometric "chord-and-tangent" method. This book carefully develops all of the tools necessary to make sense of this isomorphism. The exposition is kept as elementary as possible and frequently draws on familiar notions in calculus and algebra to motivate new concepts. Based on a capstone course given to senior undergraduates, this book is intended as a textbook for courses at this level and includes a large number of class-tested* *exercises. The prerequisites for using the book are familiarity with abstract algebra, calculus and analysis, as covered in standard undergraduate courses. Algebraic curves have many special properties that make their study particularly rewarding. As a result, curves provide a natural introduction to algebraic geometry. In this book, the authors also bring out aspects of curves that are unique to them and emphasize connections with algebra. This text covers the essential topics in the geometry of algebraic curves, such as line bundles and vector bundles, the Riemann-Roch Theorem, divisors, coherent sheaves, and zeroth and firstcohomology groups. The authors make a point of using concrete examples and explicit methods to ensure that the style is clear and understandable. Several chapters develop the connections between the geometry of algebraic curves and the algebra of one-dimensional fields. This is an interesting topic that israrely found in introductory texts on algebraic geometry. This book makes an excellent text for a first course for graduate students. The past few years have witnessed significant developments in algebraic coding theory. This book provides an advanced treatment of the subject from an engineering perspective, covering the basic principles and their application in* *communications and signal processing. Emphasis is on codes defined on the line, on the plane, and on curves, with the core ideas presented using commutative algebra and computational algebraic geometry made accessible using the Fourier transform. Starting with codes defined on a line, a background framework is established upon which the later chapters concerning codes on planes, and on curves, are developed. The decoding algorithms are developed using the standard engineering approach applied to those of Reed-Solomon codes, enabling them to be evaluated against practical applications. Integrating recent developments in the field into the classical treatment of algebraic coding, this is an invaluable resource for graduate students and researchers in telecommunications and applied mathematics. This book gives an introduction to algebraic functions and projective curves. It covers a wide range of material by dispensing with the machinery of algebraic geometry and proceeding directly via valuation theory to the main results on function fields. It also develops the theory of singular curves by studying maps to projective space, including topics such as Weierstrass points in characteristic p, and the Gorenstein relations for singularities of plane curves. This book provides an accessible and self-contained* *introduction to the theory of algebraic curves over a finite field, a subject that has been of fundamental importance to mathematics for many years and that has essential applications in areas such as finite geometry, number theory, error-correcting codes, and cryptology. Unlike other books, this one emphasizes the algebraic geometry rather than the function field approach to algebraic curves. The authors begin by developing the general theory of curves over any field, highlighting peculiarities occurring for positive characteristic and requiring of the reader only basic knowledge of algebra and geometry. The special properties that a curve over a finite field can have are then discussed. The geometrical theory of linear series is used to find estimates for the number of rational points on a curve, following the theory of Stöhr and Voloch. The approach of Hasse and Weil via zeta functions is explained, and then attention turns to more advanced results: a state-of-the-art introduction to maximal curves over finite fields is provided; a comprehensive account is given of the automorphism group of a curve; and some applications to coding theory and finite geometry are described. The book includes many examples and exercises. It is an indispensable resource for researchers and the* *ideal textbook for graduate students. Conics and Cubics offers an accessible and well illustrated introduction to algebraic curves. By classifying irreducible cubics over the real numbers and proving that their points form Abelian groups, the book gives readers easy access to the study of elliptic curves. It includes a simple proof of Bezout's Theorem on the number of intersections of two curves. The subject area is described by means of concrete and accessible examples. The book is a text for a one-semester course. An up-to-date report on the current status of important research topics in algebraic geometry and its applications, such as computational algebra and geometry, singularity theory algorithms, numerical solutions of polynomial systems, coding theory, communication networks, and computer vision. Contributions on more fundamental aspects of algebraic geometry include expositions related to counting points on varieties over finite fields, Mori theory, linear systems, Abelian varieties, vector bundles on singular curves, degenerations of surfaces, and mirror symmetry of Calabi-Yau manifolds. An accessible introduction to plane algebraic curves that also serves as a natural entry point to algebraic geometry. This second volume introduces the concept of shemes, reviews some commutative algebra and* *introduces projective schemes. The finiteness theorem for coherent sheaves is proved, here again the techniques of homological algebra and sheaf cohomology are needed. In the last two chapters, projective curves over an arbitrary ground field are discussed, the theory of Jacobians is developed, and the existence of the Picard scheme is proved. Finally, the author gives some outlook into further developments- for instance étale cohomology- and states some fundamental theorems. The moduli space Mg of curves of fixed genus g – that is, the algebraic variety that parametrizes all curves of genus g – is one of the most intriguing objects of study in algebraic geometry these days. Its appeal results not only from its beautiful mathematical structure but also from recent developments in theoretical physics, in particular in conformal field theory. Leading experts in the field explore in this volume both the structure of the moduli space of curves and its relationship with physics through quantum cohomology. Altogether, this is a lively volume that testifies to the ferment in the field and gives an excellent view of the state of the art for both mathematicians and theoretical physicists. It is a persuasive example of the famous Wignes comment, and its converse, on "the* *unreasonable effectiveness of mathematics in the natural science." Witteen's conjecture in 1990 describing the intersection behavior of tautological classes in the cohomology of Mg arose directly from string theory. Shortly thereafter a stunning proof was provided by Kontsevich who, in this volume, describes his solution to the problem of counting rational curves on certain algebraic varieties and includes numerous suggestions for further development. The same problem is given an elegant treatment in a paper by Manin. There follows a number of contributions to the geometry, cohomology, and arithmetic of the moduli spaces of curves. In addition, several contributors address quantum cohomology and conformal field theory. "... To sum up, this book helps to learn algebraic geometry in a short time, its concrete style is enjoyable for students and reveals the beauty of mathematics." --Acta Scientiarum Mathematicarum In recent years there has been enormous activity in the theory of algebraic curves. Many long-standing problems have been solved using the general techniques developed in algebraic geometry during the 1950's and 1960's. Additionally, unexpected and deep connections between algebraic curves and differential equations have been uncovered, and these in turn shed light on other* *classical problems in curve theory. It seems fair to say that the theory of algebraic curves looks completely different now from how it appeared 15 years ago; in particular, our current state of knowledge repre sents a significant advance beyond the legacy left by the classical geometers such as Noether, Castelnuovo, Enriques, and Severi. These books give a presentation of one of the central areas of this recent activity; namely, the study of linear series on both a fixed curve (Volume I) and on a variable curve (Volume II). Our goal is to give a comprehensive and self-contained account of the extrinsic geometry of algebraic curves, which in our opinion constitutes the main geometric core of the recent advances in curve theory. Along the way we shall, of course, discuss appli cations of the theory of linear series to a number of classical topics (e.g., the geometry of the Riemann theta divisor) as well as to some of the current research (e.g., the Kodaira dimension of the moduli space of curves). This is a self-contained introduction to algebraic curves over finite fields and geometric Goppa codes. There are four main divisions in the book. The first is a brief exposition of basic concepts and facts of the theory of error-correcting codes (Part I). The second is a complete presentation of the theory of* *algebraic curves, especially the curves defined over finite fields (Part II). The third is a detailed description of the theory of classical modular curves and their reduction modulo a prime number (Part III). The fourth (and basic) is the construction of geometric Goppa codes and the production of asymptotically good linear codes coming from algebraic curves over finite fields (Part IV). The theory of geometric Goppa codes is a fascinating topic where two extremes meet: the highly abstract and deep theory of algebraic (specifically modular) curves over finite fields and the very concrete problems in the engineering of information transmission. At the present time there are two essentially different ways to produce asymptotically good codes coming from algebraic curves over a finite field with an extremely large number of rational points. The first way, developed by M. A. Tsfasman, S. G. Vladut and Th. Zink [210], is rather difficult and assumes a serious acquaintance with the theory of modular curves and their reduction modulo a prime number. The second way, proposed recently by A. Algebra and number theory have always been counted among the most beautiful and fundamental mathematical areas with deep proofs and elegant results. However, for a long time they were not considered of any* *substantial importance for real-life applications. This has dramatically changed with the appearance of new topics such as modern cryptography, coding theory, and wireless communication. Nowadays we find applications of algebra and number theory frequently in our daily life. We mention security and error detection for internet banking, check digit systems and the bar code, GPS and radar systems, pricing options at a stock market, and noise suppression on mobile phones as most common examples. This book collects the results of the workshops "Applications of algebraic curves" and "Applications of finite fields" of the RICAM Special Semester 2013. These workshops brought together the most prominent researchers in the area of finite fields and their applications around the world. They address old and new problems on curves and other aspects of finite fields, with emphasis on their diverse applications to many areas of pure and applied mathematics.*

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