

Sam Ling and Chaoping Xing

Coding Theory

A First Course



Mathematics Of Coding Theory

Harald Niederreiter



Mathematics Of Coding Theory:

Introduction to Coding Theory J.H. van Lint, 2012-12-06 The first edition of this book was conceived in 1981 as an alternative to outdated oversized or overly specialized textbooks in this area of discrete mathematics a field that is still growing in importance as the need for mathematicians and computer scientists in industry continues to grow The body of the book consists of two parts a rigorous mathematically oriented first course in coding theory followed by introductions to special topics The second edition has been largely expanded and revised The main editions in the second edition are 1 a long section on the binary Golay code 2 a section on Kerdock codes 3 a treatment of the Van Lint Wilson bound for the minimum distance of cyclic codes 4 a section on binary cyclic codes of even length 5 an introduction to algebraic geometry codes Eindhoven J H VAN LINT November 1991 Preface to the First Edition Coding theory is still a young subject One can safely say that it was born in 1948 It is not surprising that it has not yet become a fixed topic in the curriculum of most universities On the other hand it is obvious that discrete mathematics is rapidly growing in importance The growing need for mathematicians and computer scientists in industry will lead to an increase in courses offered in the area of discrete mathematics One of the most suitable and fascinating is indeed coding theory *Coding Theory* Jacobus H. van Lint, 2013-12-11

Information and Coding Theory Gareth A. Jones, J. Mary Jones, 2012-12-06 As this Preface is being written the twentieth century is coming to an end Historians may perhaps come to refer to it as the century of information just as its predecessor is associated with the process of industrialisation Successive technological developments such as the telephone radio television computers and the Internet have had profound effects on the way we live We can see pictures of the surface of Mars or the early shape of the Universe The contents of a whole shelf load of library books can be compressed onto an almost weightless piece of plastic Billions of people can watch the same football match or can keep in instant touch with friends around the world without leaving home In short massive amounts of information can now be stored transmitted and processed with surprising speed accuracy and economy Of course these developments do not happen without some theoretical basis and as is so often the case much of this is provided by mathematics Many of the first mathematical advances in this area were made in the mid twentieth century by engineers often relying on intuition and experience rather than a deep theoretical knowledge to lead them to their discoveries Soon the mathematicians delighted to see new applications for their subject joined in and developed the engineers practical examples into wide ranging theories complete with definitions theorems and proofs

Algebraic Coding Theory (Revised Edition) Elwyn R Berlekamp, 2015-03-26 This is the revised edition of Berlekamp's famous book Algebraic Coding Theory originally published in 1968 wherein he introduced several algorithms which have subsequently dominated engineering practice in this field One of these is an algorithm for decoding Reed Solomon and Bose Chaudhuri Hocquenghem codes that subsequently became known as the Berlekamp Massey Algorithm Another is the Berlekamp algorithm for factoring polynomials over finite fields whose later extensions and embellishments became widely

used in symbolic manipulation systems Other novel algorithms improved the basic methods for doing various arithmetic operations in finite fields of characteristic two Other major research contributions in this book included a new class of Lee metric codes and precise asymptotic results on the number of information symbols in long binary BCH codes Selected chapters of the book became a standard graduate textbook Both practicing engineers and scholars will find this book to be of great value

The Mathematical Theory of Coding Ian F. Blake, Ronald C. Mullin, 2014-05-10 The Mathematical Theory of Coding focuses on the application of algebraic and combinatoric methods to the coding theory including linear transformations vector spaces and combinatorics The publication first offers information on finite fields and coding theory and combinatorial constructions and coding Discussions focus on self dual and quasicyclic codes quadratic residues and codes balanced incomplete block designs and codes bounds on code dictionaries code invariance under permutation groups and linear transformations of vector spaces over finite fields The text then takes a look at coding and combinatorics and the structure of semisimple rings Topics include structure of cyclic codes and semisimple rings group algebra and group characters rings ideals and the minimum condition chains and chain groups dual chain groups and matroids graphs and coding The book ponders on group representations and group codes for the Gaussian channel including distance properties of group codes initial vector problem modules group algebras and representations orthogonality relationships and properties of group characters and representation of groups The manuscript is a valuable source of data for mathematicians and researchers interested in the mathematical theory of coding

Introduction to Coding Theory Jurgen Bierbrauer, 2016-10-14 This book is designed to be usable as a textbook for an undergraduate course or for an advanced graduate course in coding theory as well as a reference for researchers in discrete mathematics engineering and theoretical computer science This second edition has three parts an elementary introduction to coding theory and applications of codes and algebraic curves The latter part presents a brief introduction to the theory of algebraic curves and its most important applications to coding theory

Introduction To Algebraic Coding Theory Tzuong-tsieng Moh, 2022-02-18 We live in the age of technology where messages are transmitted in sequences of 0 s and 1 s through space It is possible to make an error with noisy channels so self correcting codes become vital to eradicate all errors as the number of errors is small These self correcting codes are widely used in the industry for a variety of applications including e mail telephone remote sensing e g photographs of Mars amongst others We will present some essentials of the theory in this book Using linear algebra we have the salient Hamming codes The next level of coding theory is through the usage of ring theory especially polynomials rational functions and power series to produce BCH codes Reed Solomon codes and the classical Goppa codes Then we progress to the geometric Goppa code using Algebraic Geometry

The Mathematics of Coding Theory Paul B. Garrett, 2004 For undergraduate courses in Coding Theory and Network Security in departments of Mathematics Electrical Engineering and Computer Science This text makes a very accessible introduction to a very important contemporary application of number

theory abstract algebra and probability From credit cards to cellphones codes are discussed both mathematically and with regard to industry protocols Coding and Information Theory Steven Roman,1992-06-04 This book is an introduction to information and coding theory at the graduate or advanced undergraduate level It assumes a basic knowledge of probability and modern algebra but is otherwise self contained The intent is to describe as clearly as possible the fundamental issues involved in these subjects rather than covering all aspects in an encyclopedic fashion The first quarter of the book is devoted to information theory including a proof of Shannon s famous Noisy Coding Theorem The remainder of the book is devoted to coding theory and is independent of the information theory portion of the book After a brief discussion of general families of codes the author discusses linear codes including the Hamming Golary the Reed Muller codes finite fields and cyclic codes including the BCH Reed Solomon Justesen Goppa and Quadratic Residue codes An appendix reviews relevant topics from modern algebra *Different Aspects of Coding Theory* Robert Calderbank,1995 The symposia in applied mathematics have been held under the auspices of the American Mathematical Society and others since 1967 This books connects coding theory with actual applications in consumer electronics and with other areas of mathematics It covers in detail the mathematical foundations of digital data storage and makes connections to symbolic dynamics linear systems and finite automata It also explores the use of algebraic geometry within coding theory and examines links with finite geometry statistics and theoretical computer science *Elements of Algebraic Coding Theory* Lekh R. Vermani,2022-01-26 Coding theory came into existence in the late 1940s and is concerned with devising efficient encoding and decoding procedures The book is intended as a principal text for first courses in coding and algebraic coding theory and is aimed at advanced undergraduates and recent graduates as both a course and self study text BCH and cyclic Group codes Hamming codes polynomial as well as many other codes are introduced in this textbook Incorporating numerous worked examples and complete logical proofs it is an ideal introduction to the fundamental of algebraic coding Coding Theory San Ling,Chaoping Xing,2004-02-12 Coding theory is concerned with successfully transmitting data through a noisy channel and correcting errors in corrupted messages It is of central importance for many applications in computer science or engineering This book gives a comprehensive introduction to coding theory whilst only assuming basic linear algebra It contains a detailed and rigorous introduction to the theory of block codes and moves on to more advanced topics like BCH codes Goppa codes and Sudan s algorithm for list decoding The issues of bounds and decoding essential to the design of good codes features prominently The authors of this book have for several years successfully taught a course on coding theory to students at the National University of Singapore This book is based on their experiences and provides a thoroughly modern introduction to the subject There are numerous examples and exercises some of which introduce students to novel or more advanced material *Coding Theory and Design Theory* Dijen Ray-Chaudhuri,2012-12-06 This IMA Volume in Mathematics and its Applications Coding Theory and Design Theory Part I Coding Theory is based on the proceedings of a workshop which

was an integral part of the 1987-88 IMA program on APPLIED COMBINATORICS. We are grateful to the Scientific Committee Victor Klee, Chairman Daniel Kleitman, Dijen Ray Chaudhuri and Dennis Stanton for planning and implementing an exciting and stimulating year-long program. We especially thank the Workshop Organizer Dijen Ray Chaudhuri for organizing a workshop which brought together many of the major figures in a variety of research fields in which coding theory and design theory are used.

A vner Friedman Willard Miller Jr. PREFACE Coding Theory and Design Theory are areas of Combinatorics which found rich applications of algebraic structures. Combinatorial designs are generalizations of finite geometries. Probably the history of Design Theory begins with the 1847 paper of Reverend T. P. Kirkman, "On a problem of Combinatorics," Cambridge and Dublin Math Journal. The great Statistician R. A. Fisher reinvented the concept of combinatorial 2-design in the twentieth century. Extensive application of algebraic structures for construction of 2-designs balanced incomplete block designs can be found in R. C. Bose's 1939 Annals of Eugenics paper "On the construction of balanced incomplete block designs." Coding Theory and Design Theory are closely interconnected. Hamming codes can be found in disguise in R. C. Bose's 1947 Sankhya paper "Mathematical theory of the symmetrical factorial designs."

Introduction to Coding Theory and Algebraic Geometry J. van Lint, G. van der Geer, 2012-12-06. These notes are based on lectures given in the seminar on Coding Theory and Algebraic Geometry held at Schloss Mickeln, Diisseldorf, November 16-21, 1987. In 1982 Tsfasman, Vladut, and Zink, using algebraic geometry and ideas of Goppa, constructed a sequence of codes that exceed the Gilbert-Varshamov bound. The result was considered sensational. Furthermore, it was surprising to see these unrelated areas of mathematics collaborating. The aim of this course is to give an introduction to coding theory and to sketch the ideas of algebraic geometry that led to the new result. Finally, a number of applications of these methods of algebraic geometry to coding theory are given. Since this is a new area, there are presently no references where one can find a more extensive treatment of all the material. However, both for algebraic geometry and for coding theory, excellent textbooks are available. The combination of the two subjects can only be found in a number of survey papers. A book by C. Moreno with a complete treatment of this area is in preparation. We hope that these notes will stimulate further research and collaboration of algebraic geometers and coding theorists.

G. van der Geer, J. H. van Lint. **Introduction to Coding Theory and Algebraic Geometry, Part I: Coding Theory.** Jacobus H. van Lint, 11-1. Finite fields. In this chapter, we collect without proof the facts from the theory of finite fields that we shall need in this course.

Coding Theory and Cryptology Harald Niederreiter, 2002. The inaugural research program of the Institute for Mathematical Sciences at the National University of Singapore took place from July to December 2001 and was devoted to coding theory and cryptology. As part of the program, tutorials for graduate students and junior researchers were given by world-renowned scholars. These tutorials covered fundamental aspects of coding theory and cryptology and were designed to prepare for original research in these areas. The present volume collects the expanded lecture notes of these tutorials. The topics range from mathematical areas such as computational number theory, exponential sums, and algebraic function fields through

coding theory subjects such as extremal problems quantum error correcting codes and algebraic geometry codes to cryptologic subjects such as stream ciphers public key infrastructures key management authentication schemes and distributed system security

Concise Encyclopedia of Coding Theory W. Cary Huffman, Jon-Lark Kim, Patrick Solé, 2021-03-25 Most coding theory experts date the origin of the subject with the 1948 publication of *A Mathematical Theory of Communication* by Claude Shannon Since then coding theory has grown into a discipline with many practical applications antennas networks memories requiring various mathematical techniques from commutative algebra to semi definite programming to algebraic geometry Most topics covered in the Concise Encyclopedia of Coding Theory are presented in short sections at an introductory level and progress from basic to advanced level with definitions examples and many references The book is divided into three parts Part I fundamentals cyclic codes skew cyclic codes quasi cyclic codes self dual codes codes and designs codes over rings convolutional codes performance bounds Part II families AG codes group algebra codes few weight codes Boolean function codes codes over graphs Part III applications alternative metrics algorithmic techniques interpolation decoding pseudo random sequences lattices quantum coding space time codes network coding distributed storage secret sharing and code based cryptography Features Suitable for students and researchers in a wide range of mathematical disciplines Contains many examples and references Most topics take the reader to the frontiers of research

Coding Theory and Number Theory T. Hiramatsu, Günter Köhler, 2003-04-30 This book grew out of our lectures given in the Oberseminar on Coding Theory and Number Theory at the Mathematics Institute of the Würzburg University in the Summer Semester 2001 The coding theory combines mathematical elegance and some engineering problems to an unusual degree The major advantage of studying coding theory is the beauty of this particular combination of mathematics and engineering In this book we wish to introduce some practical problems to the mathematician and to address these as an essential part of the development of modern number theory The book consists of five chapters and an appendix Chapter 1 may mostly be dropped from an introductory course of linear codes In Chapter 2 we discuss some relations between the number of solutions of a diagonal equation over finite fields and the weight distribution of cyclic codes Chapter 3 begins by reviewing some basic facts from elliptic curves over finite fields and modular forms and shows that the weight distribution of the Melas codes is represented by means of the trace of the Hecke operators acting on the space of cusp forms Chapter 4 is a systematic study of the algebraic geometric codes For a long time the study of algebraic curves over finite fields was the province of pure mathematicians In the period 1977-1982 V D Goppa discovered an amazing connection between the theory of algebraic curves over finite fields and the theory of q-ary codes

A First Course in Coding Theory Raymond Hill, 1986 Algebraic coding theory is a new and rapidly developing subject popular for its many practical applications and for its fascinatingly rich mathematical structure This book provides an elementary yet rigorous introduction to the theory of error correcting codes Based on courses given by the author over several years to advanced

undergraduates and first year graduated students this guide includes a large number of exercises all with solutions making the book highly suitable for individual study **Algebraic and Stochastic Coding Theory** Dave K. Kythe, Prem K. Kythe, 2017-07-28 Using a simple yet rigorous approach Algebraic and Stochastic Coding Theory makes the subject of coding theory easy to understand for readers with a thorough knowledge of digital arithmetic Boolean and modern algebra and probability theory It explains the underlying principles of coding theory and offers a clear detailed description of each code More advanced readers will appreciate its coverage of recent developments in coding theory and stochastic processes After a brief review of coding history and Boolean algebra the book introduces linear codes including Hamming and Golay codes It then examines codes based on the Galois field theory as well as their application in BCH and especially the Reed Solomon codes that have been used for error correction of data transmissions in space missions The major outlook in coding theory seems to be geared toward stochastic processes and this book takes a bold step in this direction As research focuses on error correction and recovery of erasures the book discusses belief propagation and distributions It examines the low density parity check and erasure codes that have opened up new approaches to improve wide area network data transmission It also describes modern codes such as the Luby transform and Raptor codes that are enabling new directions in high speed transmission of very large data to multiple users This robust self contained text fully explains coding problems illustrating them with more than 200 examples Combining theory and computational techniques it will appeal not only to students but also to industry professionals researchers and academics in areas such as coding theory and signal and image processing

Coding Theory and Design Theory Dijen Ray-Chaudhuri, 1990

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Table of Contents Mathematics Of Coding Theory

1. Understanding the eBook Mathematics Of Coding Theory
 - The Rise of Digital Reading Mathematics Of Coding Theory
 - Advantages of eBooks Over Traditional Books
2. Identifying Mathematics Of Coding Theory
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Mathematics Of Coding Theory
 - User-Friendly Interface
4. Exploring eBook Recommendations from Mathematics Of Coding Theory
 - Personalized Recommendations
 - Mathematics Of Coding Theory User Reviews and Ratings
 - Mathematics Of Coding Theory and Bestseller Lists
5. Accessing Mathematics Of Coding Theory Free and Paid eBooks
 - Mathematics Of Coding Theory Public Domain eBooks
 - Mathematics Of Coding Theory eBook Subscription Services
 - Mathematics Of Coding Theory Budget-Friendly Options

6. Navigating Mathematics Of Coding Theory eBook Formats
 - ePub, PDF, MOBI, and More
 - Mathematics Of Coding Theory Compatibility with Devices
 - Mathematics Of Coding Theory Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Mathematics Of Coding Theory
 - Highlighting and Note-Taking Mathematics Of Coding Theory
 - Interactive Elements Mathematics Of Coding Theory
8. Staying Engaged with Mathematics Of Coding Theory
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Mathematics Of Coding Theory
9. Balancing eBooks and Physical Books Mathematics Of Coding Theory
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Mathematics Of Coding Theory
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Mathematics Of Coding Theory
 - Setting Reading Goals Mathematics Of Coding Theory
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Mathematics Of Coding Theory
 - Fact-Checking eBook Content of Mathematics Of Coding Theory
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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