

Song Y. Yan

# Number Theory for Computing

2nd Edition



Springer

# Number Theory For Computing

**P. J. Giblin**



## Number Theory For Computing:

**Number Theory for Computing** Song Y. Yan, 2013-11-11 Modern cryptography depends heavily on number theory with primality testing factoring discrete logarithms indices and elliptic curves being perhaps the most prominent subject areas Since my own graduate study had emphasized probability theory statistics and real analysis when I started working in cryptography around 1970 I found myself swimming in an unknown murky sea I thus know from personal experience how inaccessible number theory can be to the uninitiated Thank you for your efforts to ease the transition for a new generation of cryptographers Thank you also for helping Ralph Merkle receive the credit he deserves Diffie Rivest Shamir Adleman and I had the good luck to get expedited review of our papers so that they appeared before Merkle's seminal contribution Your noting his early submission date and referring to what has come to be called Diffie Hellman key exchange as it should Diffie Hellman Merkle key exchange is greatly appreciated It has been gratifying to see how cryptography and number theory have helped each other over the last twenty five years Number theory has been the source of numerous clever ideas for implementing cryptographic systems and protocols while cryptography has been helpful in getting funding for this area which has sometimes been called the queen of mathematics because of its seeming lack of real world applications Little did they know Stanford 30 July 2001 Martin E Hellman Preface to the Second Edition Number theory is an experimental science

*Number Theory with Computer Applications* Ramanujachary Kumanduri, Cristina Romero, 1998 Appropriate for most courses in Number Theory This book effectively integrates computing algorithms into the number theory curriculum using a heuristic approach and strong emphasis on proofs Its in depth coverage of modern applications considers the latest trends and topics such as elliptic curves a subject that has seen a rise in popularity due to its use in the proof of Fermat's Last Theorem **Algorithmic Number Theory: Efficient algorithms** Eric Bach, Jeffrey Outlaw Shallit, 1996 Volume 1

Elementary Number Theory with Programming Marty Lewinter, Jeanine Meyer, 2015-05-06 A highly successful presentation of the fundamental concepts of number theory and computer programming Bridging an existing gap between mathematics and programming Elementary Number Theory with Programming provides a unique introduction to elementary number theory with fundamental coverage of computer programming Written by highly qualified experts in the fields of computer science and mathematics the book features accessible coverage for readers with various levels of experience and explores number theory in the context of programming without relying on advanced prerequisite knowledge and concepts in either area Elementary Number Theory with Programming features comprehensive coverage of the methodology and applications of the most well known theorems problems and concepts in number theory Using standard mathematical applications within the programming field the book presents modular arithmetic and prime decomposition which are the basis of the public private key system of cryptography In addition the book includes Numerous examples exercises and research challenges in each chapter to encourage readers to work through the discussed concepts and ideas Select solutions

to the chapter exercises in an appendix Plentiful sample computer programs to aid comprehension of the presented material for readers who have either never done any programming or need to improve their existing skill set A related website with links to select exercises An Instructor s Solutions Manual available on a companion website Elementary Number Theory with Programming is a useful textbook for undergraduate and graduate level students majoring in mathematics or computer science as well as an excellent supplement for teachers and students who would like to better understand and appreciate number theory and computer programming The book is also an ideal reference for computer scientists programmers and researchers interested in the mathematical applications of programming *Primes and Programming* P. J. Giblin,1993-09-02 In this introductory book Dr Giblin describes methods that have been developed for testing the primality of numbers provides Pascal programs for their implementation and gives applications to coding *Algorithmic Number Theory* J. P. Buhler,P. Stevenhagen,2008-10-20 An introduction to number theory for beginning graduate students with articles by the leading experts in the field *Computational Number Theory and Modern Cryptography* Song Y. Yan,2013-01-29 The only book to provide a unified view of the interplay between computational number theory and cryptography Computational number theory and modern cryptography are two of the most important and fundamental research fields in information security In this book Song Y Yang combines knowledge of these two critical fields providing a unified view of the relationships between computational number theory and cryptography The author takes an innovative approach presenting mathematical ideas first thereupon treating cryptography as an immediate application of the mathematical concepts The book also presents topics from number theory which are relevant for applications in public key cryptography as well as modern topics such as coding and lattice based cryptography for post quantum cryptography The author further covers the current research and applications for common cryptographic algorithms describing the mathematical problems behind these applications in a manner accessible to computer scientists and engineers Makes mathematical problems accessible to computer scientists and engineers by showing their immediate application Presents topics from number theory relevant for public key cryptography applications Covers modern topics such as coding and lattice based cryptography for post quantum cryptography Starts with the basics then goes into applications and areas of active research Geared at a global audience classroom tested in North America Europe and Asia Includes exercises in every chapter Instructor resources available on the book s Companion Website Computational Number Theory and Modern Cryptography is ideal for graduate and advanced undergraduate students in computer science communications engineering cryptography and mathematics Computer scientists practicing cryptographers and other professionals involved in various security schemes will also find this book to be a helpful reference *Computational Excursions in Analysis and Number Theory* Peter Borwein,2012-12-06 This book is designed for a topics course in computational number theory It is based around a number of difficult old problems that live at the interface of analysis and number theory Some of these problems are the following The Integer Chebyshev Problem Find a nonzero

polynomial of degree  $n$  with integer coefficients that has smallest possible supremum norm on the unit interval Littlewood's Problem Find a polynomial of degree  $n$  with coefficients in the set  $[-1, 1]$  that has smallest possible supremum norm on the unit disk The Prouhet-Tarry-Escott Problem Find a polynomial with integer coefficients that is divisible by  $z^n - 1$  and has smallest possible  $L^1$  norm That  $L^1$  is the sum of the absolute values of the coefficients is minimal Lehmer's Problem Show that any monic polynomial  $p(z) = z^n + a_{n-1}z^{n-1} + \dots + a_0$  with integer coefficients that is irreducible and that is not a cyclotomic polynomial has Mahler measure at least  $1 + \frac{1}{2n}$  All of the above problems are at least forty years old all are presumably very hard certainly none are completely solved and all lend themselves to extensive computational explorations The techniques for tackling these problems are various and include probabilistic methods combinatorial methods the circle method and Diophantine and analytic techniques Computationally the main tool is the LLL algorithm for finding small vectors in a lattice The book is intended as an introduction to a diverse collection of techniques

**Cryptology and Computational Number Theory** Carl Pomerance, Shafi Goldwasser, 1990 In the past dozen or so years cryptology and computational number theory have become increasingly intertwined Because the primary cryptologic application of number theory is the apparent intractability of certain computations these two fields could part in the future and again go their separate ways But for now their union is continuing to bring ferment and rapid change in both subjects This book contains the proceedings of an AMS Short Course in Cryptology and Computational Number Theory held in August 1989 during the Joint Mathematics Meetings in Boulder Colorado These eight papers by six of the top experts in the field will provide readers with a thorough introduction to some of the principal advances in cryptology and computational number theory over the past fifteen years In addition to an extensive introductory article the book contains articles on primality testing discrete logarithms integer factoring knapsack cryptosystems pseudorandom number generators the theoretical underpinnings of cryptology and other number theory based cryptosystems Requiring only background in elementary number theory this book is aimed at nonexperts including graduate students and advanced undergraduates in mathematics and computer science

*A Computational Introduction to Number Theory and Algebra* Victor Shoup, 2005-04-28 This introductory book emphasises algorithms and applications such as cryptography and error correcting codes

**Introduction to Number Theory with Computing** R. B. J. T. Allenby, E. J. Redfern, 1989-01-01 This introduction to number theory has been written specifically for mathematics and computing undergraduates Computer programs in BASIC are accompanied by basic text which explains the subject and demonstrates how computers have opened up new horizons for number theorists

Quantum Computational Number Theory Song Y. Yan, 2015-12-26 This book provides a comprehensive introduction to advanced topics in the computational and algorithmic aspects of number theory focusing on applications in cryptography Readers will learn to develop fast algorithms including quantum algorithms to solve various classic and modern number theoretic problems Key problems include prime number generation primality testing integer factorization discrete logarithms elliptic curve arithmetic conjecture and numerical

verification The author discusses quantum algorithms for solving the Integer Factorization Problem IFP the Discrete Logarithm Problem DLP and the Elliptic Curve Discrete Logarithm Problem ECDLP and for attacking IFP DLP and ECDLP based cryptographic systems Chapters also cover various other quantum algorithms for Pell's equation principal ideal unit group class group Gauss sums prime counting function Riemann's hypothesis and the BSD conjecture Quantum Computational Number Theory is self contained and intended to be used either as a graduate text in computing communications and mathematics or as a basic reference in the related fields Number theorists cryptographers and professionals working in quantum computing cryptography and network security will find this book a valuable asset

Computational Number Theory Abhijit Das, 2013-03-18 Developed from the author's popular graduate level course Computational Number Theory presents a complete treatment of number theoretic algorithms Avoiding advanced algebra this self contained text is designed for advanced undergraduate and beginning graduate students in engineering It is also suitable for researchers new to the field and practitioners of cryptography in industry Requiring no prior experience with number theory or sophisticated algebraic tools the book covers many computational aspects of number theory and highlights important and interesting engineering applications It first builds the foundation of computational number theory by covering the arithmetic of integers and polynomials at a very basic level It then discusses elliptic curves primality testing algorithms for integer factorization computing discrete logarithms and methods for sparse linear systems The text also shows how number theoretic tools are used in cryptography and cryptanalysis A dedicated chapter on the application of number theory in public key cryptography incorporates recent developments in pairing based cryptography With an emphasis on implementation issues the book uses the freely available number theory calculator GP PARI to demonstrate complex arithmetic computations The text includes numerous examples and exercises throughout and omits lengthy proofs making the material accessible to students and practitioners

**Finite Fields: Theory and Computation** Igor

Shparlinski, 2013-03-09 This book is mainly devoted to some computational and algorithmic problems in finite fields such as for example polynomial factorization finding irreducible and primitive polynomials the distribution of these primitive polynomials and of primitive points on elliptic curves constructing bases of various types and new applications of finite fields to other areas of mathematics For completeness we include two special chapters on some recent advances and applications of the theory of congruences optimal coefficients congruential pseudo random number generators modular arithmetic etc and computational number theory primality testing factoring integers computation in algebraic number theory etc The problems considered here have many applications in Computer Science Coding Theory Cryptography Numerical Methods and so on There are a few books devoted to more general questions but the results contained in this book have not till now been collected under one cover In the present work the author has attempted to point out new links among different areas of the theory of finite fields It contains many very important results which previously could be found only in widely scattered

and hardly available conference proceedings and journals In particular we extensively review results which originally appeared only in Russian and are not well known to mathematicians outside the former USSR     **Primes and Programming**,1993     Number Theory in Science and Communication M.R. Schroeder,2005-11-03 Number Theory in Science and Communication introduces non mathematicians to the fascinating and diverse applications of number theory This best selling book stresses intuitive understanding rather than abstract theory This revised fourth edition is augmented by recent advances in primes in progressions twin primes prime triplets prime quadruplets and quintuplets factoring with elliptic curves quantum factoring Golomb rulers and baroque integers     **Primes and Programming** P. J. Giblin,1993     *Number Theory in Science and Communication* Manfred Schroeder,2008-11-06 Number Theory in Science and Communication is a well known introduction for non mathematicians to this fascinating and useful branch of applied mathematics It stresses intuitive understanding rather than abstract theory and highlights important concepts such as continued fractions the golden ratio quadratic residues and Chinese remainders trapdoor functions pseudo primes and primitive elements Their applications to problems in the real world are one of the main themes of the book This revised fifth edition is augmented by recent advances in coding theory permutations and derangements and a chapter in quantum cryptography From reviews of earlier editions I continue to find Schroeder s Number Theory a goldmine of valuable information It is a marvelous book in touch with the most recent applications of number theory and written with great clarity and humor Philip Morrison Scientific American A light hearted and readable volume with a wide range of applications to which the author has been a productive contributor useful mathematics outside the formalities of theorem and proof Martin Gardner     Finite Fields: Theory and Computation Igor Shparlinski,1999-05-31 This book is mainly devoted to some computational and algorithmic problems in finite fields such as for example polynomial factorization finding irreducible and primitive polynomials the distribution of these primitive polynomials and of primitive points on elliptic curves constructing bases of various types and new applications of finite fields to other areas of mathematics For completeness we include two special chapters on some recent advances and applications of the theory of congruences optimal coefficients congruential pseudo random number generators modular arithmetic etc and computational number theory primality testing factoring integers computation in algebraic number theory etc The problems considered here have many applications in Computer Science Coding Theory Cryptography Numerical Methods and so on There are a few books devoted to more general questions but the results contained in this book have not till now been collected under one cover In the present work the author has attempted to point out new links among different areas of the theory of finite fields It contains many very important results which previously could be found only in widely scattered and hardly available conference proceedings and journals In particular we extensively review results which originally appeared only in Russian and are not well known to mathematicians outside the former USSR     **Computers in Number Theory** Donald D. Spencer,1982

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