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Intro to Number Theory: Solutions Dr. David M. Goulet  
November 14, 2007 Preliminaries Base 10 Arithmetic Problems □ What is  $7777_8 + 1$  in base 8? Solution: In base 10, 7

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+ 1 = 8, but in base 7,  $7 + 1 = 10$ . So  $7777+1 = 7770+10 = 7700+100 = 7000+1000 = 10000$ . □ In what base is 212 equal to 225 10? Solution: call the base  $b$ . Then in base 10,  $(2 \square b + 1)2 = 225$ . So

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about numbers and to discover methods of proof on their own. It is designed...

Number Theory Through Inquiry - David C. Marshall, Edward

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The systematic study of number theory was initiated around 300B.C. when Euclid proved that there are infinitely many prime numbers, and also cleverly deduced the fundamental theorem of arithmetic, which asserts that every positive integer factors uniquely as a product of primes.

Elementary Number Theory: Primes, Congruences, and Secrets

Student Learning Outcomes: Students will prove theorems

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and solve problems in number theory, and communicate their results orally and in writing. Required Materials: Number Theory Through Inquiry by David C. Marshall, Edward Odell, and Michael Starbird, Mathematical Association of America Textbooks, 2007, ISBN-10: 0883857510, ISBN-13: 978 ...

Introduction to Number Theory Spring 2014 MWF 2:50 pm

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Textbook: Number Theory Through Inquiry, D. Marshall, E. Odell, M. Starbird. Course description: This course will be held in an Inquiry Based Learning format. In this method, the students will be required to prove the theorems themselves and present them to the class. After or during student presentations, the class will ask questions of

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Number Theory Through Inquiry Solutions Manual  
Number Theory Through Inquiry, by Marshall, Odell, and Starbird, Chs. 1-5. This book differs from other texts for proof-based courses, in that the proofs of the theorems are not included. The point of this is for you, the student, to fill in these details, in order to be more actively involved with the

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material.

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This innovative textbook leads students on a carefully guided discovery of introductory number theory. The book has two equally significant goals. The first is to help students develop mathematical thinking skills, particularly theorem-proving skills. The other goal is to help students understand some of the wonderfully rich ideas in the mathematical study of

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numbers. This book is appropriate for a proof transitions course, for independent study, or for a course designed as an introduction to abstract mathematics. It is designed to be used with an instructional technique variously called guided discovery or Modified Moore Method or Inquiry Based Learning (IBL). Instructors' materials explain the instructional method, which gives students a totally different experience compared to a standard lecture course. Students develop an attitude of personal reliance and a sense that they can think effectively about difficult problems; goals that are fundamental to the educational enterprise within and beyond mathematics.

Number Theory Through Inquiry is an innovative textbook that leads students on a carefully guided discovery of introductory

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number theory. The book has two equally significant goals. One goal is to help students develop mathematical thinking skills, particularly, theorem-proving skills. The other goal is to help students understand some of the wonderfully rich ideas in the mathematical study of numbers. This book is appropriate for a proof transitions course, for an independent study experience, or for a course designed as an introduction to abstract mathematics. Math or related majors, future teachers, and students or adults interested in exploring mathematical ideas on their own will enjoy Number Theory Through Inquiry. Number theory is the perfect topic for an introduction-to-proofs course. Every college student is familiar with basic properties of numbers, and yet the exploration of those familiar numbers leads us to a rich landscape of ideas.



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Number Theory Through Inquiry contains a carefully arranged sequence of challenges that lead students to discover ideas about numbers and to discover methods of proof on their own. It is designed to be used with an instructional technique variously called guided discovery or Modified Moore Method or Inquiry Based Learning (IBL). Instructors' materials explain the instructional method. This style of instruction gives students a totally different experience compared to a standard lecture course. Here is the effect of this experience: Students learn to think independently: they learn to depend on their own reasoning to determine right from wrong; and they develop the central, important ideas of introductory number theory on their own. From that experience, they learn that they can personally create important ideas, and they develop

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an attitude of personal reliance and a sense that they can think effectively about difficult problems. These goals are fundamental to the educational enterprise within and beyond mathematics.

Right triangles are at the heart of this textbook's vibrant new approach to elementary number theory. Inspired by the familiar Pythagorean theorem, the author invites the reader to ask natural arithmetic questions about right triangles, then proceeds to develop the theory needed to respond. Throughout, students are encouraged to engage with the material by posing questions, working through exercises, using technology, and learning about the broader context in which ideas developed. Progressing from the fundamentals of

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number theory through to Gauss sums and quadratic reciprocity, the first part of this text presents an innovative first course in elementary number theory. The advanced topics that follow, such as counting lattice points and the four squares theorem, offer a variety of options for extension, or a higher-level course; the breadth and modularity of the later material is ideal for creating a senior capstone course. Numerous exercises are included throughout, many of which are designed for SageMath. By involving students in the active process of inquiry and investigation, this textbook imbues the foundations of number theory with insights into the lively mathematical process that continues to advance the field today. Experience writing proofs is the only formal prerequisite for the book, while a background in basic real

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analysis will enrich the reader's appreciation of the final chapters.

Challenge: Can you find all the integers  $a, b, c$  satisfying  $2a^2+3b^2=5c^2$ ? Looks simple, and there are in fact a number of easy solutions. But most of them turn out to be anything but obvious! There are infinitely many possibilities, and as any computer will tell you, each of  $a, b, c$  will usually be large. So the challenge remains – Find all integers  $a, b, c$  satisfying  $2a^2+3b^2=5c^2$  A major advance in number theory means this book can give an easy answer to this and countless similar questions. The idea behind the approach is transforming a degree-two equation in integer variables  $a, b, c$  into a plane curve defined by a polynomial. Working with the

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curve makes obtaining solutions far easier, and the geometric solutions then get translated back into integers. This method morphs hard problems into routine ones and typically requires no more than high school math. (The complete solution to  $2a^2+3b^2=5c^2$  is included in the book.) In addition to equations of degree two, the book addresses degree-three equations—a branch of number theory that is today something of a cottage industry, and these problems translate into elliptic curves. This important part of the book includes many pictures along with the exposition, making the material meaningful and easy to grasp. This book will fit nicely into an introductory course on number theory. In addition, the many solved examples, illustrations, and exercises make self-studying the book an option for students, thus becoming a

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natural candidate for a capstone course.

Geometry and the theory of numbers are as old as some of the oldest historical records of humanity. Ever since antiquity, mathematicians have discovered many beautiful interactions between the two subjects and recorded them in such classical texts as Euclid's Elements and Diophantus's Arithmetica. Nowadays, the field of mathematics that studies the interactions between number theory and algebraic geometry is known as arithmetic geometry. This book is an introduction to number theory and arithmetic geometry, and the goal of the text is to use geometry as the motivation to prove the main theorems in the book. For example, the fundamental theorem of arithmetic is a consequence of the tools we develop in

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order to find all the integral points on a line in the plane. Similarly, Gauss's law of quadratic reciprocity and the theory of continued fractions naturally arise when we attempt to determine the integral points on a curve in the plane given by a quadratic polynomial equation. After an introduction to the theory of diophantine equations, the rest of the book is structured in three acts that correspond to the study of the integral and rational solutions of linear, quadratic, and cubic curves, respectively. This book describes many applications including modern applications in cryptography; it also presents some recent results in arithmetic geometry. With many exercises, this book can be used as a text for a first course in number theory or for a subsequent course on arithmetic (or diophantine) geometry at the junior-senior level.

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Number Theory is a newly translated and revised edition of the most popular introductory textbook on the subject in Hungary. The book covers the usual topics of introductory number theory: divisibility, primes, Diophantine equations, arithmetic functions, and so on. It also introduces several more advanced topics including congruences of higher degree, algebraic number theory, combinatorial number theory, primality testing, and cryptography. The development is carefully laid out with ample illustrative examples and a treasure trove of beautiful and challenging problems. The exposition is both clear and precise. The book is suitable for both graduate and undergraduate courses with enough material to fill two or more semesters and could be used as a



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source for independent study and capstone projects. Freud and Gyarmati are well-known mathematicians and mathematical educators in Hungary, and the Hungarian version of this book is legendary there. The authors' personal pedagogical style as a facet of the rich Hungarian tradition shines clearly through. It will inspire and exhilarate readers.

This manual is written to accompany Mathematical Interest Theory, by Leslie Jane Federer Vaaler and James Daniel. It includes detailed solutions to the odd-numbered problems. There are solutions to 239 problems, and sometimes more than one way to reach the answer is presented. In keeping with the presentation of the text, calculator discussions for the Texas Instruments BA II Plus or BA II Plus Professional

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calculator is typeset in a different font from the rest of the text.

Number theory is one of the few areas of mathematics where problems of substantial interest can be fully described to someone with minimal mathematical background. Solving such problems sometimes requires difficult and deep methods. But this is not a universal phenomenon; many engaging problems can be successfully attacked with little more than one's mathematical bare hands. In this case one says that the problem can be solved in an elementary way. Such elementary methods and the problems to which they apply are the subject of this book. *Not Always Buried Deep* is designed to be read and enjoyed by those who wish to explore elementary methods in modern number theory. The

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heart of the book is a thorough introduction to elementary prime number theory, including Dirichlet's theorem on primes in arithmetic progressions, the Brun sieve, and the Erdos-Selberg proof of the prime number theorem. Rather than trying to present a comprehensive treatise, Pollack focuses on topics that are particularly attractive and accessible. Other topics covered include Gauss's theory of cyclotomy and its applications to rational reciprocity laws, Hilbert's solution to Waring's problem, and modern work on perfect numbers. The nature of the material means that little is required in terms of prerequisites: The reader is expected to have prior familiarity with number theory at the level of an undergraduate course and a first course in modern algebra (covering groups, rings, and fields). The exposition is complemented by over 200

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exercises and 400 references.

Topology Through Inquiry is a comprehensive introduction to point-set, algebraic, and geometric topology, designed to support inquiry-based learning (IBL) courses for upper-division undergraduate or beginning graduate students. The book presents an enormous amount of topology, allowing an instructor to choose which topics to treat. The point-set material contains many interesting topics well beyond the basic core, including continua and metrizable spaces. Geometric and algebraic topology topics include the classification of 2-manifolds, the fundamental group, covering spaces, and homology (simplicial and singular). A unique feature of the introduction to homology is to convey a clear geometric

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motivation by starting with mod 2 coefficients. The authors are acknowledged masters of IBL-style teaching. This book gives students joy-filled, manageable challenges that incrementally develop their knowledge and skills. The exposition includes insightful framing of fruitful points of view as well as advice on effective thinking and learning. The text presumes only a modest level of mathematical maturity to begin, but students who work their way through this text will grow from mathematics students into mathematicians.

Michael Starbird is a University of Texas Distinguished Teaching Professor of Mathematics. Among his works are two other co-authored books in the Mathematical Association of America's (MAA) Textbook series. Francis Su is the Benediktsson-Karwa Professor of Mathematics at Harvey

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Mudd College and a past president of the MAA. Both authors are award-winning teachers, including each having received the MAA's Haimo Award for distinguished teaching. Starbird and Su are, jointly and individually, on lifelong missions to make learning of mathematics and beyond joyful, effective, and available to everyone. This book invites topology students and teachers to join in the adventure.

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