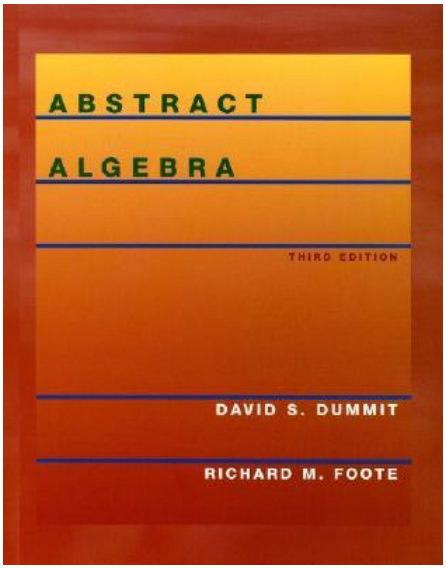

Abstract Algebra

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Widely acclaimed algebra text. This book is designed to give the reader insight into the power and beauty that accrues from a rich interplay between different areas of mathematics. The book carefully develops the theory of different algebraic structures, beginning from basic definitions to some in-depth results, using numerous examples and exercises to aid the reader's understanding. In this way, readers gain an appreciation for how mathematical structures and their interplay lead to powerful results and insights in a number of different settings.
* The emphasis throughout has been to motivate the introduction and development of important algebraic concepts using as many examples as possible.

Abstract Algebra Details

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From Reader Review Abstract Algebra for online ebook

Chris says

I used this for self-study over the course of a year or so. In that time, worked the problems in chapters 0-14 and 18-19. From a learner's perspective, this book is very, very good. The text is clear, thorough and humble, and the exercises are excellent. The longer, multi-part exercises often help the reader to an interesting, non-trivial result in manageable steps. I'm very thankful for this wonderful book.

Shiwani says

Nice

Dan says

This book is dense and huge. So you know it has a ton of information.

I don't know if it is the best treatment of the material, but it is thorough (maybe even TOO thorough.)

But all in all it was the best algebra textbook I've ever had.

Used it all year in a graduate algebra course, and fortunately my torrid love affair with it has come to an end...

What I learned from this book:

commutative algebra, field theory, representation theory (sort of,) galois theory, and algebraic geometry.

Ming says

Used this book for Group Theory, Ring Theory, Module Theory and Galois Theory for the Honors Algebra Sequence in UChicago. Pretty good book - some very basic exercises, some suitably challenging ones; the exposition is relatively lucid and organised, the pacing comfortably slow (you don't have to do too much filling in of the gaps when it comes to proofs of important theorems and results). A pretty decent introduction to fundamentals of Abstract Algebra.

Angm81 says

I certainly wouldn't say I liked this book, but I wouldn't say I liked any advanced math textbook. It did help me survive a 600-level Abstract Algebra class, though. The book itself was frustrating in a lot of the typical math textbook ways (i.e. using "clearly..." and "obviously..." in proofs to avoid explaining yourself; if it's clear and obvious, then it should be easy enough for you to state it, so do so!). I found it beyond annoying for another reason, though: the blatant disregard for use of standard grammar. It is common, in the middle of a proof, for mathematicians to start a sentence with "then" or "therefore" but not follow it with a comma, as grammar conventions would recommend. I can overlook that. But, Dummit and Foote will open a sentence with a lengthy prepositional phrase, and then lead into the rest of the sentence without inserting the comma necessary to make their intended meaning understandable. For example, "For G a group and x in G define the order of x to be the smallest..." While it may be easy to identify where the comma should go in some instances, there were multiple occasions throughout this book when I had to reread a sentence several times to understand whether a phrase was part of the independent clause, dependent clause, etc. I know you're mathematicians, but you didn't get a PhD without surviving an English class or two. Your editor dropped the ball, too. In the end, it just makes you look lazy for not caring enough to check the little things, and it makes your textbook that much less effective. You should be striving for clarity in order to assist students who are trying to learn Algebra. Instead, you're requiring them to waste time and brain power, both valuable commodities in grad school, to try to decipher your writing.

Terran says

If you're going to study Abstract Algebra on your own, from texts, this is absolutely the place to do it. Thorough, clear, readable, in-depth, and yet not "concise" in that sense that mathematicians mean "readable only by experts in the field".

Nishant Pappireddi says

I am a student at UC Berkeley who is studying mathematics. Nine months ago, my friend sent me a pdf of this book because I was interested to see what kind of problems were being assigned in her Algebra class. Ever since then, I have become more and more enamored with Algebra, and this book has been critical in allowing me to discover its beauty and power.

As a general note, the layout of the book (in terms of aesthetic appearance) is actually among the best that I've seen in math textbooks. The prose is often very dense at times, but usually the statements and proofs are not too difficult to follow. There are a lot of important and insightful examples provided in every section of the book, and many of the things that are not covered in the prose are covered in the exercises, which by the way are excellent: a large number of exercises are multi-part ones that "hand hold" you through the proof of a major/cute/interesting result. Some of these included proving that there are infinitely many primes congruent to 1 modulo any integer, classifying groups of certain orders, and determining which primes 2 is a quadratic residue modulo. Although these types of exercises may not be the best for improving your problem solving skills, it does feel good to apply things you've just learned to prove a nontrivial and interesting result. Because of this, I think I can safely say that I learned at least as much from doing the exercises as from reading the book.

Now I'll discuss the various parts of the book in greater detail:

Chapter 0 talked about very very basic stuff, like set theoretic notation and properties of the integers. This should definitely be review for anyone with a decent math background.

Chapters 1-6 were on Group Theory. This is actually what got me interested in Algebra, since they're relatively simple objects and yet one can still deduce a lot of interesting things about them. One of my favorite types of exercises was classifying all the groups of a given order. This started small, but after the Sylow theorems, (semi)direct products, and the Fundamental Theorem of Finite Abelian Groups, there were exercises concerning much larger orders. There were even exercises asking to prove that A5 is the only nonabelian simple group of order 100 or less, and that there are no odd order nonabelian simple groups of order less than 10,000, though I didn't do either of those completely.

Of course, there were other important topics covered, such as matrix groups (mostly relegated to the exercises), group actions (one of my other favorite group theory topics, especially applied to combinatorics and symmetry groups). The Jordan-Holder Theorem was discussed and proved in the exercises, as were nilpotent and solvable groups, along with their various group series. The Frattini subgroup was entirely relegated to the exercises but there were a large number of exercises about its basic properties. Finally, there was a very nice constructive proof of the existence and uniqueness of a simple group of order 168, as the automorphism group of the Fano Plane. Unfortunately, linear groups were not discussed as much as I may have liked, the group theoretic material that was discussed was plenty to whet my appetite!

Chapters 7-9 introduce Ring Theory. Once again, the text and exercises were excellent. Chapter 7 introduces basic properties, including ideals and ring homomorphisms, the field of fractions, and the Chinese Remainder Theorem. Boolean Rings are also introduced in the exercises. Chapter 8 proves the famous chain of implications ED->PID->UFD, and thus gets the Fundamental Theorem of Arithmetic for free. The text and exercises also proved whether or not various quadratic integer rings were ED's or PID's, as well as polynomial rings. Speaking of which, Chapter 9 talked about polynomial rings, and how they're ED's in one variable over a field, UFD's in more variables, as well as irreducibility criteria. Finally, the last, long, section was about Grobner bases. The theory was very interesting, since it described algortihms for solving nonlinear systems of polynomial equations, but I did not really enjoy the exercises where I had to compute them by hand. Despite this, they are useful, especially in the later chapter on Algebraic Geometry.

Chapters 10-12 were on Module Theory. Chapter 10 introduces modules (vector spaces over rings) and some of their basic properties. Of course, they're not as nice as vector spaces, but they're still rather interesting. The penultimate section of the chapter talked about the infamous tensor products. It's very confusing at first, but once I understood their universal property (any bilinear map from the Cartesian product of two modules must factor through the tensor product), the exercises became much easier. The final section, on Exact Sequences and Projective/Injective/Flat Modules was even more confusing, but the exercises helped me understand them more (which I guess is what they're there for).

Chapter 11 talked about Vector Spaces and thus was mostly review for me, since I had just taken a linear algebra class. We used Axler's excellent book "Linear Algebra Done Right," the infamous "determinant-free" book, but nevertheless, determinants were presented in an interesting way (as an alternating bilinear map), and in this book, unlike in Axler's, we can use that every vector space has a basis. One important result proved in the exercises is that an infinite dimensional vector space is strictly smaller than its dual. There were also a lot of exercises about row reduction of matrices, which were rather annoying to me, but I guess proving facts about row reduction is preferable to actually having to do it. The last section of this chapter talked about tensor products of vector spaces, as well as symmetric and alternating tensors and algebras. This was the hardest part of the chapter to understand, but since I saw tensor products already, the vector space version was much easier.

Chapter 12 was actually among my favorite chapters, not only because it proved an amazing and beautiful result, but also because it tied together all the subjects that had come before it, including group theory, ring theory, polynomials, module theory, and linear algebra. By proving the Fundamental Theorem of Finitely Generated Modules over a PID, we automatically get the Fundamental Theorem of Finitely Generated Abelian Groups (since abelian groups are just Z-modules), and with a little bit of work, we also get the Rational Canonical Form and Jordan Form for linear operators. Of course, with this came interesting exercises, including exercises on the matrix exponential, but of course there were algorithmic and computational exercises that I mostly skipped. On the last lecture for my Linear Algebra class, my professor discussed the connection between the Jordan Form and the Fundamental Theorem of Finite Abelian Groups, which was really cool, and when my friend asked me to explain the Jordan Form, I was able to point to the results of this chapter to make the construction much clearer than it might have been using pure linear algebra (like in Axler's book).

Chapters 13 and 14 cover Field and Galois Theory. The first chapter covers the basics of field extensions (including the Lifting Lemma and the isomorphism of splitting fields), and also determines which numbers are constructible with straightedge and compass and thus proves the impossibility of the 3 classical construction problems. The final section is on cyclotomic extensions, which are later used to determine which regular polygons are constructible, as well as to study extensions containing roots of unity.

Chapter 14 is actually another one of my favorite chapters, since it covers Galois Theory, which is one of the most beautiful subjects in mathematics, since it brings together field theory and group theory, allowing us to use the tools of both fields (no pun intended). This chapter covers the classification of finite fields, the Galois Groups of cubic/quartic/quintic polynomials, the cubic/quartic formulas, and of course the insolvability of the quintic. The final sections are on Galois Groups of higher degree polynomials, and separable, transcendental, and infinite extensions. Of course, the exercises in this chapter were great: in particular, they introduced Newton's formulas, the resolvent and the resultant, as well as the norm and trace maps. In addition, there were many fun exercises about various Galois Groups, even over fields of positive characteristic, and these exercises were actually the most fun part of my trip to Hawaii.

Chapters 15-17 cover Algebraic Geometry, Commutative Algebra, and Homological Algebra. I actually sis this part last, after Representation Theory, since it seemed like it would be the hardest, and I was right. This part seems a bit more disconnected compared to the other parts, but it was still a good introduction. Chapter 15 covered Algebraic Geometry, including radical ideals, Primary Decomposition, Integral extensions, the Nullstellensatz, the Zariski Topology, Localization, and the Prime Spectrum of a ring. The last section lost me almost completely when it started talking about sheaves, and I'm not sure I fully grasped the material, but I'll be taking an Algebraic Geometry class soon, so hopefully that will fill in some of the gaps. I did like doing many of the topology exercises, since it was a nice way for me to relearn some definitions from Analysis. Chapter 16 discusses Artinian Rings, Discrete Valuation Rings, and Dedekind Domains, mostly stating and proving the structure theorems for these rings. This was a nice short chapter about some cute rings, and I got to see a tiny taste of Algebraic Number Theory! Chapter 17 talked about various homological functors. The 1st talked about Ext and Tor, the second started applying cohomology to study groups, and the last two sections made the connection between the 1st and 2nd cohomology groups and group extensions. The last section got a bit confusing since they mixed additive and multiplicative notation for groups. I'm not quite sure I understood the significance of what was going on in the chapter, but the exercises were still mostly fun, and maybe I'll understand this more after taking Algebraic Topology.

Chapters 18-19, the final two chapters, covered Representation Theory. Wedderburn's Theorem, which classified group rings over a field, was pretty cool, and in general, this part was all about using the power of linear algebra to gain more information about (finite) groups. This included character theory and the orthogonality relations, which led to nice and short proofs of Burnside's pq Theorem and Hall's Theorem.

The final section also discussed Frobenius Groups, which were fascinating to me; unfortunately, there was not enough room to develop them in full detail, but some nice results were proven. The exercises were cute too, and they discussed proving Burnside's Lemma using Representation Theory, proving Schur's Lemma, proving there is no simple group of order 1004913, and (my favorite) classifying all finite subgroups of GL2(Q).

The appendices briefly covered Cartesian Products, Zorn's Lemma, and Category Theory. The former topics, in the first appendix, were straightforward, but I had trouble wrapping my head around the Category Theory concepts, since there was a lot of stuff going on at once, and since the appendix was way to short for a really good introduction.

Overall, working through (almost) all the problems in this book was a really fun goal for me, and I learned a lot, both from the text and from the exercises. This is an excellent book to learn Algebra from, especially since you can prove many major results for yourself instead of having the proof given to you. I hope others find this book as wonderful as I did!

Qubitng says

Had to use it for undergrad algebra decades ago. Can't see the tree because there are too many leaves. Not recommended as the primary text at the undergrad level but maybe as a source for exercises.

David says

Going on 6 years of "currently reading."

Jovany Agathe says

Wonderful book.

AJ says

This book is certainly, as it proposes, thorough (as far as group theory, I can vouch) and certainly attains a readability that Hungerford lacks and an adherence to standard notational conventions (in the more advanced algebraic regimes such as Lie algebras) in which Lang is deficient. However, their style is slow.
For independent study at a leisurely pace, of group theory, this book is a good first source. It has a good collection of exercises overall, and these should be worked out instead of skipped.

Justin says

Wow. Another page turner. This is a wonderful text for anyone looking to learn abstract algebra. No wonder it's called the algebra bible! David S. Dummit weaves in tons of juicy examples for basically all the stories. He doesn't really leave a lot of things as a mystery for the reader. Everything is pretty crystal clear and up front. If you're looking for a mystery novel, this is not the choice for you. Sometimes I wish he left even more proofs as exercises for the readers. That would have really kept me at the edge of my seat. I guess he made a stylistic choice so I won't argue against it.

One thing I really liked was his story progression. First, he starts with groups, possibly alluding to his own experiences with groups. When he talks about how some groups are cyclic, it was heart wrenching. Those groups just toss you around and around without getting you anywhere! Then he talks about rings. While groups are concerned about just one binary operation, rings are concerned about two operations. He really did a good job tying in his poly amorous relationships in this one, especially when he discusses what he finds ideal and how to choose rings that lead to wonderful results. Then he goes on to more rings and discusses about representation and character. This part was a little more philosophical and socioanalytical. He goes from radicals to french groups to Descartes. I can really see a maturing character progression in this chapter. A person with a lack of maturity will not be able to understand or relate to this part of the novel.

I have never read anything by Dummit before. Nonetheless, I was completely blown away by this piece of work. Looking through some of his other works, it was disappointing. Not because they were poorly written, but just because I read his magnum opus first. If you have a love of algebra, pick this up! You will not regret it.

John Hammond says

Excellent book on Algebra.

Waffles says

It's a math text, so I didn't enjoy reading it, but it is a good comprehensive overview of algebra. I'm glad this was the text for my algebra sequence.

Une says

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