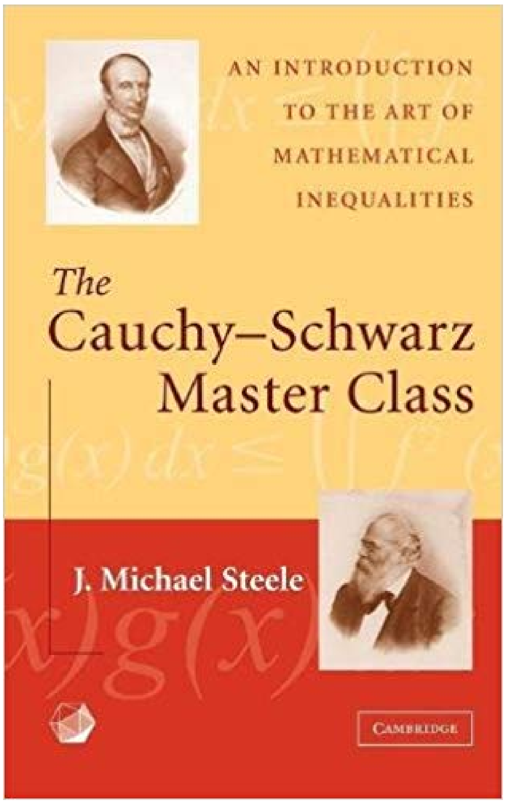
The Cauchy-Schwarz Master Class: An Introduction to the Art of Mathematical Inequalities (Maa Problem Books Series.) *by* J. Michael Steele



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Michael Steele describes the fundamental topics in mathematical inequalities and their uses. Using the Cauchy-Schwarz inequality as a guide, Steele presents a fascinating collection of problems related to inequalities and coaches readers through solutions, in a style reminiscent of George Polya, by teaching basic concepts and sharpening problem solving skills at the same time. Undergraduate and beginning graduate students in mathematics, theoretical computer science, statistics, engineering, and economics will find the book appropriate for self-study.

Reviews of the The Cauchy-Schwarz Master Class: An Introduction to the Art of Mathematical Inequalities (Maa Problem Books Series.) *by* J. Michael Steele

Joni_Dep
The Cauchy-Schwarz Master Class is perhaps amongst the best mathematics book that I have seen in many years. True to its name, it is indeed a Master Class. I came across this book 4-5 months ago purely by accident in a bookstore. Sat there and casually read the first chapter and within 30 minutes I was hooked! I regret not coming across it earlier. The author has a rare talent for exposition, replete with interesting historical digressions and very inviting challenge problems. You can literally feel the author's enthusiasm for inequalities while reading the book, and most importanly; he manages to infect you with it! I could not put aside the book completely once I had picked it up and eventually decided to go all the way, slowly over the last 4-5 months (still left with two chapters and some problems). The problems are addictive. Often, when I did pick up the book, I found myself doing nothing but thinking about the exercises I was trying to solve.

Like most great books, the way it is organized makes it "very natural" to rediscover many susbtantial results (some of them named) appearing much later by yourself, provided you happen to just ask the right questions. I believe that this is the sole trademark of a truly remarkable book. This happened with me quite a few times. However, I would like to recount a particular example. I was tutoring a freshman in Linear Algebra around the time I bought the book. I mentioned the book to him and it eventually so happened that I lent it to him for a week. He was stuck with exercise 1.6 (which is an innocuous inequality at first glance). He eventually managed to solve it without hints. However, not only did he manage to solve it but using an insight from there he was able to ask the right question - what happens when you replace the second power with something else? What can you replace it with? In essence he was able to take 1.6 (in which the powers summed to one and this was mentioned) and prove a version of Holder's just by using the inductive proof described in the prior chapter (he hadn't heard of Holder's). I was equally amazed when I was able to formulate and prove some inequalities that actually appeared later in the book.

The book emphasizes a problem solving approach and features a large number of inequalities (while also relating them all the time) which makes sure you make very good friends with some of the most interesting inequalities. Like mentioned earlier, the exercise questions are very well chosen: For example, in the first chapter an exercise (not too hard once one has worked through the challenge problems) is proving the Cramer-Rao lower bound, a cornerstone of modern statistics. Another remarkable example is a "defect form" of Cauchy-Schwarz that is a central component in the proof of the Szemeredi Regularity Lemma, one of the most fundamental results in Graph Theory. All these examples are remarkably provable after reading and working out challenge problems. Steele also often stuns in his digressions. For example: There is a part when the goal is to derive Lagrange's Identity. We move to establish this by trying to "measure" the defect in Cauchy-Schwarz (with is a polynomial). We soon show that this polynomial can be expressed as a sum of squares (and is thus always non-negative). Then we look at Minkowski's conjecture that tries to ask if non-negativity of a polynomial always implies a sum-of-squares. We then learn that it is not possible to do this. However a simple modification to this is Hilbert's 17th problem!

The book starts off with the inequalities dealing with "natural" notions such as monotonicity and positivity (which appear very frequently in Olympiads) and later builds onto somewhat less natural and more advanced notions such as convexity. The book also manages to convey a sense of appreciation of why Cauchy-Schwarz is such a fundamental inequality (by relating it to many different notions such as isometry, isoperimetric inequalities, convexity etc etc). It is a little strange that Cauchy-Schwarz keeps appearing all the time. What makes it so useful and fundamental is indeed quite interesting and non-obvious. It is also not at all clear why is it that it is Cauchy-Schwarz which is mainly useful.

I can't recommend this book enough. It is truly a gem!
Dordred
In many respects this is one of my very favorite math books. I'm tempted to say it is simply the best in a lot of ways. The worked problems and explanations in the chapters are very high quality, and the exercises (with thoughtful solutions) are very good. As the author notes, there is a lot of variety in the book, making it a quality companion for a course in analysis, probability or combinatorics. Plus inequalities don't seem to be taught very well, and this book really does 'teach' you them.

I dinged this one star because the book has the thickest errata sheet I've ever seen. There are even comments in the errata sheet (for example regarding ex 6.8) saying that a problem is fatally flawed and the author plans to update it in 2007. A decade passes and still no update or re-prints of the book.

Still, all things considered, I love this book.

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edit: I decided to upgrade this to 5 stars. Even a few months after finishing it, I find myself re-visiting a few topics in the book and liking it even more. It really is outstanding.
Jusari
Professor Steele has done a wonderful job in developing the theory behind the Cauchy-Schwarz inequality. He starts off with the basic theory and then through the course of the book he teases out the limitless ways the inequality can be used. There is a breathtaking sweep of applications. What is interesting and valuable about his approach is that as he develops the building blocks he explains why or why not a particular approach might not work. I think there is quite a bit of Polya's inspiration in his approach. For instance, he gives Polya's proof of the Carleman inequality which, on it face, is almost outrageously unbelievable (where does the "e" come from?) but by that stage you worked through the challenge problems and the other material and it is possible to see why the "e" makes sense.

The challenge problems are excellent and his solutions sometimes skip over some important steps which a teacher could get students to fill in so that they can demonstrate that they understand the material.

There is a lot to learn from this book and it should be read by everyone who is seriously interested in mathematics. The classic Hardy-Littlewood-Polya book on inequalities is a quite different beast but the two together provide the serious reader with a depth of understanding that is hard to surpass.
Kirizan
This book's topic, mathematical inequalities, could be considered too esoteric to justify a book for more than a small niche audience of mathematicians. Yet this is an exceptionally well-written book that should appeal not only to those who might need inequalities in their work, but also to any student of mathematics who wants to learn how to discover and present elegant proofs. The only prerequisites are a familiarity with series, sequences, and standard notation in calculus and linear algebra.

In addition to its core content, the book does something that too few books in mathematics do: Provide a solution for every exercise. This makes it a precious resource for independent study.
Alister

It oozes ingenuity and it is told masterfully. An absolute delight.
happy light
this book deals in a friendly fashion with inequalities (and therefore) with the elementary use of convexity and integrals.
Famous inequalities bear the name of famous mathematicians, e.g: Tchebychev, Hilbert, Cauchy, Hardy, Rademacher...This is one way to understand their significance in maths. This book is about those ones and others such as 3/2 < a/(b+c) + b/(c+a) + c/(a+b) and the many ways to tackle with the fact of proving and using them. Study of this book should be seen as a good and rewarding path towards improving one's mathematical skills .

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