

“Pass It On” A Young Mathematician’s Preservation of a Culture yet to Be Forgotten

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Mathematics –a culture whose foundation rests on the tradition of inheriting previous mathematicians’ book collections– has found itself juxtaposed against a society dramatically changing due to recent advancements in technology; students opt for e-books; young people instinctively search the internet for solutions; and researchers possess calculators and computers operating tens of thousands of times faster than at the turn of the 20th century. Although such utilizations have their benefits, they have overshadowed a rich history left buried in forgotten books that are now at risk of dying. Over the past four years, I have continuously increased my personal collection of over 350 books, articles, and newsletters in an attempt to preserve the lessons left by previous mathematicians in the form of texts and ensure they are passed down to the next generation. The name of this collection was inspired by the theme of Ian Stewart’s *Letters to a Young Mathematician*; guide the next wave of young mathematicians. However, one cannot fully comprehend the significance of my collection without learning about the culture of mathematics and how I became involved in this community.

Physical math books carry both literal and figurative weight. For some people, math books evoke anxiety and dark flashbacks to college calculus. Yet, mathematicians have traditionally seen them as a form of time capsules containing invaluable sources of knowledge. Previous owners’ names marked on the inside covers resemble a sort of graffiti; notes penciled in the margins form conversations; and most importantly, the text itself showcases the author’s lifelong dedication to their craft. Such treasures cannot be obtained from e-books, only from the inheritance of physical copies. Moreover, although exaggerated for dramatic effect, my first research advisor once said, “Mathematicians don’t buy a book for the entire book; they buy a book for one page in the book, that’s not in any other book.” This quote emphasizes that the uniqueness each book possesses, whether from the material contained in the page or the author’s

style of writing, justifies its place in my library. This realization inspires me to treat every item in my collection with the utmost respect and earnestly strive to find the pearl each one hides.

It is common practice for mathematicians to entrust their libraries when they retire or pass away to their students and previous institutions. However, as upcoming mathematicians gradually prefer online texts over hardcopies, it falls upon book collectors such as me to ensure the knowledge, wisdom, and personalities sketched into books by the former generations survives. The margin notes that deceased mathematicians left in my textbooks have provided unmatched insight that I otherwise could not have found anywhere else. I have benefited from books where the previous owners made corrections to incorrect statements, rephrased an author's confusing choice of words, and referenced other pages elsewhere in the book. Thus, I believe that guiding the next generation of mathematicians entails preserving inherited books for situations where we discover online resources no longer suffice.

This collection started when I began undergraduate research four years ago, yet the library it became was not my initial intent. My accumulation of books happened naturally, expanding to its current size overnight. The passion and adoration I have developed for my books was instilled in me by my first advisor; and hers instilled by her previous professors. I recall our weekly research meetings in her office that first summer, my eyes constantly fixated on the shelves of books that seemingly acted as wallpaper. It was challenging to refrain from enthusiasm when she would start "nerding out" on her own collection, practically marketing books that she described as "well-written" and "classics in my [her] field of research." Upon which I always left her office feeling an urge to someday "nerd out" on books of my own; books that I could also be equally enthusiastic about.

The first book of my collection was Roger Knobel's *An Introduction to the Mathematical*

Theory of Waves, the first book my advisor and I read together. I remember experiencing the intense feeling of imposter syndrome trying to comprehend what felt like a literal *wave* of new convoluted equations, to which she recommended I investigate other texts for clarification. This led me to Boyce and DiPrima's *Elementary Differential Equations and Boundary Value Problems*, which led me to Nakhle Asmar's *Partial Differential Equations with Fourier Series and Boundary Value Problems*, and so forth until I reached an epiphany; each book contains a "piece of the puzzle," and with each piece its image becomes clearer. At that moment, my ongoing acquisition of books became second-nature. The puzzle started as chapter one from Knobel's book before I quickly realized it extends to all of mathematics. This puzzle is something abstract and intangible that mathematicians strive to complete despite knowing its completion is unfeasible.

Over the next few years, I sought advice from my professors on which books they considered to be "classics" in their fields of research. I acquired my books online, secondhand, and from inheritance, aiming to assemble as many of the puzzle pieces as possible. Back-alley bookstores are a primary source of books, my favorites being Magus Books in Seattle and The Last Word Bookshop in Philadelphia. Settled right next to the University of Washington and University of Pennsylvania, respectively, professors occasionally sell their used books to these stores. Whereas roughly half of my collection was bought, the other half was inherited from deceased faculty at my undergraduate and graduate institutions.

The personality of a collection is deeply intertwined with the items an owner is particularly proud to display. To portray my collection's unique personality, I describe a few books that I am proud to have in my library, for various reasons. The first being a first edition copy of Walter Rudin's *Principles of Mathematical Analysis*, the value of which lies not in

rarity, but cultural significance and contribution to the world of mathematics. Since its inception, this text has become a classic due its rigorous problem sets, which upon completing signifies tremendous mathematical maturity. Commonly referred to as “Baby Rudin,” (with the sequel called “Papa Rudin”) it is used by nearly every graduate program in the world. Like countless mathematicians before me, I too spent many months with its never-ending exercises. Currently on its third edition, Baby Rudin has undergone several revisions. Yet, I find owning an original copy of such a culturally significant text profoundly impassioning.

Before mentioning my second artifact, I must describe my definition of “beautiful mathematics.” I consider myself both an applied mathematician and mechanical engineer, and consequently lie in a gray-zone within the scientific community; I am between mathematicians that accentuate underlying theory and engineers that emphasize physical intuition and applications. Unfortunately, increased theory often comes at the sacrifice of physical intuition, and vice versa. Only an author highly educated in both fields can feasibly satisfy both viewpoints. Even then, constructing such a refined text presents immense difficulties from keeping the philosophies disjoint, yet complementary. Hence, books that coherently weave the two perspectives such that the text is comprehensive to both mathematicians and engineers are seldom found in literature; these are the books I deem contain “beautiful mathematics.”

Given this definition, the second item I am proud to own is a first edition copy of Carslaw and Jaeger’s *Operational Methods in Applied Mathematics*, formerly owned and signed by one of the most accomplished mathematicians of the 20th century, Ian Sneddon. Combining theory and application with ease and clarity, the authors’ mathematics are gratifying to read. Moreover, aside from his research, Ian Sneddon is remembered for his attention to detail and distinctive, immaculate handwriting that mathematicians claim was a privilege to witness; I can now attest

such claims. Possessing a book so elegantly written and signed by a prolific mathematician that also found it worthy of their bookshelf makes me pleased to show off this almost museum-worthy artifact.

Finally, the third book is irreplaceable, holds the most sentimental value, and is a source of inspiration; it is a signed copy of my late graduate professor's first published textbook. A stern, yet kind, professor with considerably high expectations, he instilled the work ethic and motivation that has carried me through the rigor of a doctoral education in applied mathematics. He consistently managed to bring the best out of his students, myself included, regarding both mathematics and personality. Before his untimely death, I would visit his home to thank him for the immeasurable advice he had given me. He signed my copy of his book and wrote the motivational last words, "Keep up with your passion and interest for advanced maths. They'll bring you joy, challenges, a mixture of happiness and 'frustration,' and above all, a life of thoughtfulness and intelligence you won't find anywhere else." The only attributes more meaningful about a book than its rarity and the notes scribbled in its margins are the wholehearted messages one person leaves for someone else. Whether it be last words of wisdom from professor to student, congratulatory letters for finishing a Ph.D., or simply messages of friendship, physical books can carry more than just the mathematics. Unlike e-books, they act as mediums that carry priceless emotion and wisdom from one mathematician to another.

My collection serves the purposes of preserving stories left behind in the margins and front covers of books for other mathematicians; providing a personalized, word-of-mouth reference library the internet fails to emulate; and recording my mathematical journey. These purposes are what make my collection unique and representative of myself. In fact, my collection is currently used as an open library for my fellow graduate students at the University of

Delaware. The seemingly abrupt technological change mathematical culture is experiencing has its upside, but it need not imply that we should forget its history and traditions. And so, to ensure this collection continues to fulfill its duties, I will steadily proliferate it one puzzle piece at a time.

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In this bibliography, I provide annotated descriptions for selected items that provide the backbone of my collection; books that I believe represent my life and the culture of mathematics. The chosen items hold personal, historical, or cultural significance to my life and/or their respective fields of study. Moreover, I use the following legend throughout to indicate additional meaning and purpose:

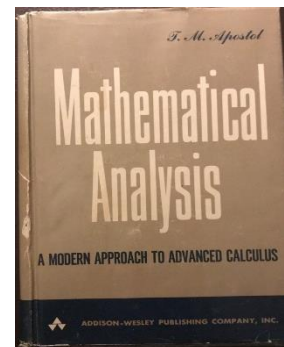
* signed by the author(s) and/or significant previous owners

classics (including modern classics) in their respective fields of study, known to the extent of my knowledge

Calculus & Analysis (Real/Complex/Fourier)

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7. # T.M. Apostol, *Calculus*, 1st edition, **2**, Blaisdell Publishing Company, Waltham, MA, 1962.
8. # **T.M. Apostol, *Mathematical Analysis*, 1st edition, Addison-Wesley Publishing Company, USA, 1957.**

Considered a classic in real analysis alongside the book by Walter Rudin (see annotation further down the list), Apostol offers a textbook that is meticulously clear, in which he guides the reader from one idea into the next. Unlike other books more terse in nature, this book flows smoothly line-by-line and allows the reader to explicitly see the meanings and connections behind topics such as convergence, boundedness, compactness, and continuity.

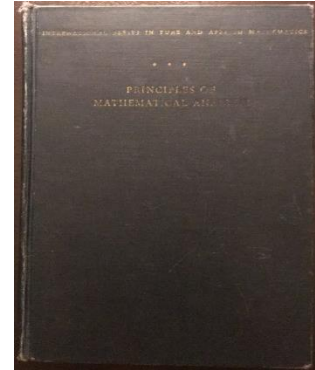


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15. R.C. Buck, *Advanced Calculus*, McGraw-Hill, New York, NY, 1956.
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26. W.M. Kelley, *The Humongous Book of Calculus Problems*, Penguin Group, New York, NY, 2006.
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38. # **W. Rudin, *Principles of Mathematical Analysis*, 1st edition, McGraw-Hill, New York, NY, 1953.**

Unarguably, the largest intersection between pure and applied mathematics is the study of real analysis. Nicknamed “Baby Rudin” by the mathematics community (“Papa Rudin” is the sequel), Rudin introduces real analysis in this beautifully clear, albeit dense, classic textbook that to this day has been used by most graduate programs worldwide. Yet, the true significance of this book lies in the challenging problem sets, where each exercise requires deep thinking and intuition in order to build one’s own mathematical maturity; by the end of which the reader will have made great strides in their knowledge.



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A collection of mathematical texts would be incomplete without a proper introductory calculus book, and Spivak’s *Calculus* is second only possibly to Apostol’s *Calculus*. Having become a household book that mathematicians say “(mathematics) majors *should* learn calculus from,” Spivak introduces the typical topics of differentiation and integration from an analyst’s more theoretical viewpoint simultaneously with standard computation, a truly mathematical masterpiece.

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47. A. Kasman, *Glimpses of Soliton Theory*, American Mathematical Society, Providence, RI, 2010.
48. **R. Knobel, *An Introduction to the Mathematical Theory of Waves*, American Mathematical Society, Providence, RI, 2000.**

Knobel offers a clean and succinct introduction to partial differential equations commonly seen in wave research (e.g., Sine-Gordon, Wave, Korteweg-deVries, Burgers, etc.), as well as elementary methods to investigate such equations. With the guidance of a professor, the author's restraint from diving too deep into the theory makes this book appealing to undergrad students and allows undergrads to gain a physical intuition before learning more advanced techniques. This book holds deep personal meaning since it was the text my first research advisor guided me through; in essence, it was the start of this collection.

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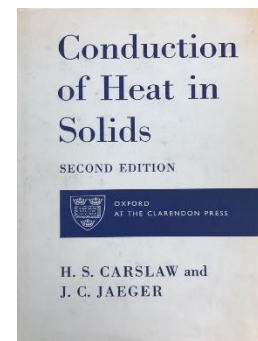
Referred by some mathematicians as the “Bible of numerical analysis,” Ralston and Rabinowitz’s classic textbook lays a clear foundation of fundamentals matched by few others. Ralston and Rabinowitz follow the standard ordering of topics: interpolation; quadratures; functional approximations; ordinary differential equations and systems. However, what sets this text apart from similar books is the unique balance of computation and theory, only providing proofs that fully complement the application; they avoid the risk of overwhelming a student first learning this material.

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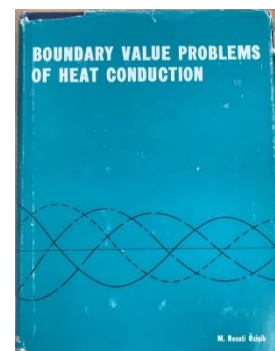
As mentioned in the preface of the first edition, Professor Jaeger was responsible for most of the writing of this beautiful classic of heat conduction. It is extremely rare to find a mathematician that writes clean-cut, clear mathematics, and Jaeger effortlessly manages to do so in this book. Carslaw and Jaeger connect the mathematical theory of heat to physical intuition, following which they offer step-by-step solutions to several problems that hold real-world applications (e.g., heat flow in a parallelepiped, cylinder, between two parallel plates, etc.); these problems are great to use in a graduate-level applied mathematics course.



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The late Professor Ozisik taught at North Carolina State University and was considered a world-leading teacher and expert in heat transfer, as is demonstrated in this book by his exquisite clarity and attention to both mathematical and engineering detail. In this textbook, Ozisik describes a general integral transform technique to solve boundary value problems pertaining to the generalized heat equation in Cartesian, cylindrical, and spherical coordinate systems; he builds the method from scratch, starting with the physical properties and then constructing the mathematical solutions.



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I believe mathematicians learn to write “good mathematics” two ways: reading well-written books and journals, and learning directly from others; the latter of which this book suffices. Higham understands that the ability to write clear scientific papers is essential for the preservation of mathematics. This book is a “mathematical grammar” teacher, discussing important lessons such as: the difference between “the”, “a”; choosing appropriate titles; using equations appropriately in sentences; citations; and how to flow one idea into the next.

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22. **P.J. Nahin, *Oliver Heaviside: The Life, Work, and Times of an Electrical Genius of the Victorian Age*, The Johns Hopkins University Press, Baltimore, MD, 2002.**

Professor Nahin does Oliver Heaviside's life justice with this moving biography of the overlooked genius. Nahin spent several years researching Heaviside's life and research in order to write this book, in which he describes Heaviside's ingenious mathematics/physics despite a lack of formal higher education; boisterous ridicule of mathematical society that arguably led to his forgotten image; and how Heaviside's development of operational calculus helped spur the advancement of research in differential equations and electrical engineering.

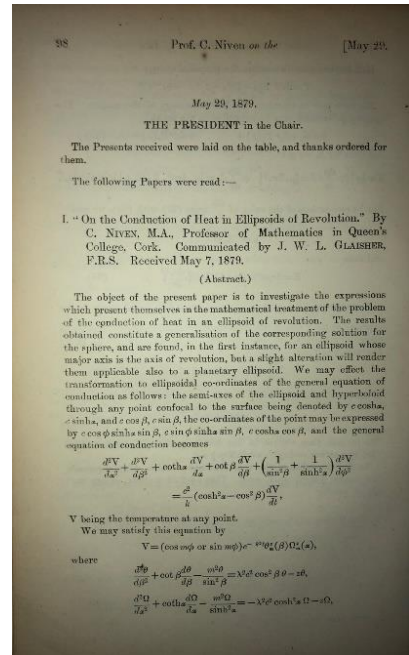
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Widely considered a book that should be in every mathematician's library, Polya clearly articulates how mathematics should be approached and thus inherently taught. He offers a sequence of steps that one should take in tackling a mathematical problem: understand the problem; make a plan; carry out the plan; reflect. For anyone involved in teaching mathematics, whether it be tutoring, lecturing, or presenting, this is a must-read classic!

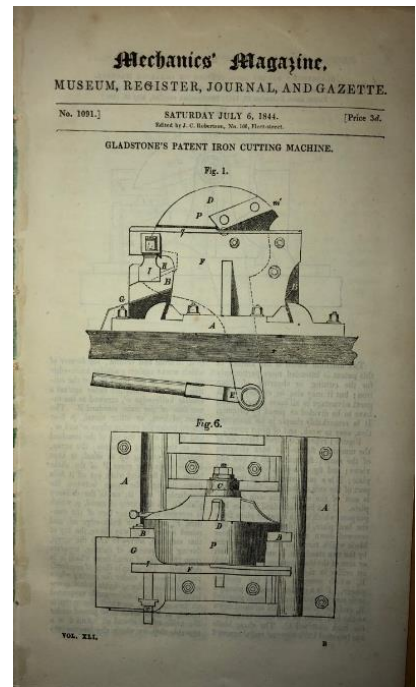
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34. **I. Stewart, *Letters to a Young Mathematician*, Basic Books, New York, NY, 2006.**

The inspiration for the name of this collection, Ian Stewart's book consists of chapters in the form of letters written by the author to a fictional young girl, Meg, offering her guidance as

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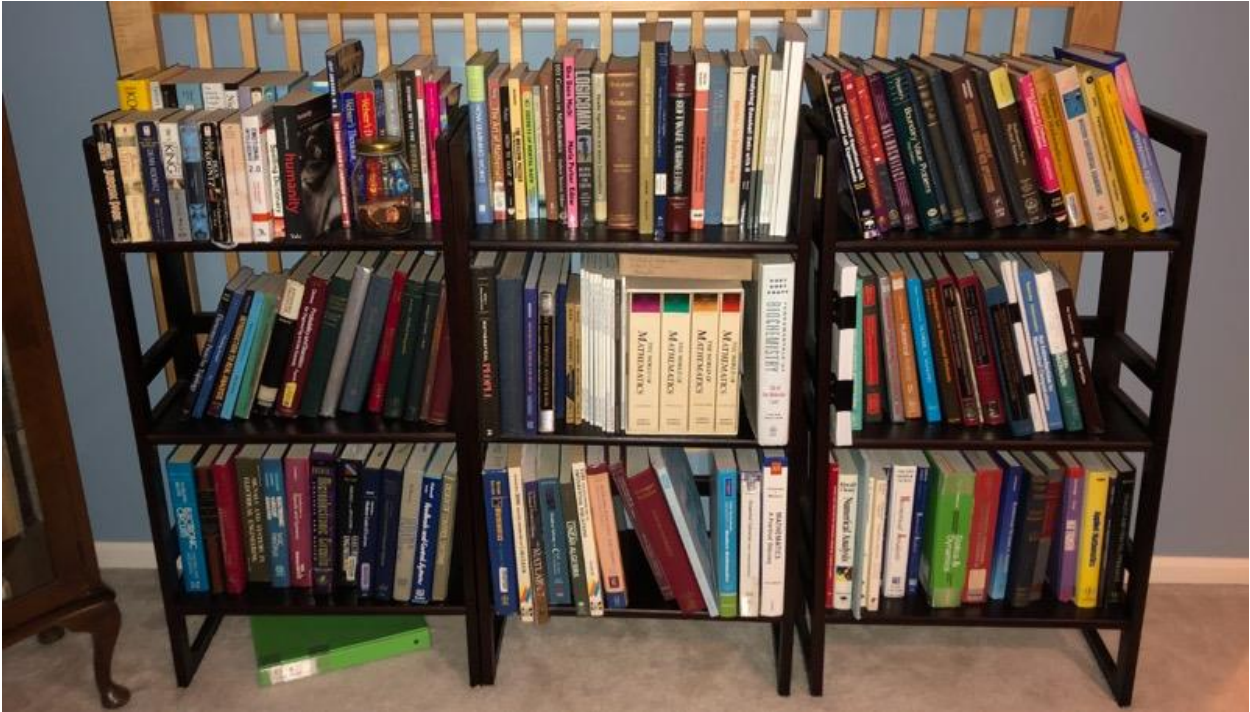


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319 books, 33 newsletters, 3 Papers

From left to right (below): A subset of older books in my collection located off-site (Seattle, WA); Check-out library in office space at the University of Delaware; Items in my apartment (Newark, DE).



Above: Items in off-site storage (Seattle, WA).

Want List

1. **T.A. Driscoll and R.J. Braun, *Fundamentals of Numerical Computation*, SIAM, Philadelphia, PA, 2017.**

Professors Driscoll and Braun are faculty in the University of Delaware mathematics department whose book overlaps with my research interests. I had the privilege of taking Dr. Driscoll's class my first semester of graduate school, and as with my signed copy of the book published by my late professor, Francisco-Javier Sayas, the addition of another one of my professors' books will deepen my collection's personal significance.

2. **O. Heaviside, *Electromagnetic Theory*, 1, 1st edition, The Electrician Printing and Publishing, London, UK, 1893.**

Oliver Heaviside's unique life as a self-taught scientist that did not let societal expectations inhibit his personality, as written in his biography by Paul Nahin, makes him my foremost influential historical figure. Although unbelievably rare due to its minimal circulation, a first edition copy of this book (written by my favorite mathematician) would add monumental value, both personal and historical, to my collection.

3. **E. Kreyszig, *Advanced Engineering Mathematics*, 1st edition, John Wiley and Sons, New York, NY, 1962.**

Since the first edition, Kreyszig's *Advanced Engineering Mathematics* has been the classic textbook from which to teach mathematics to graduate engineering students. As I discussed in my essay, I consider myself equal parts mathematician and engineer, and having an original copy of a classic text that intersects my two backgrounds would fully encapsulate my interests into this collection.

4. **M.N. Ozisik, *Finite Difference Methods in Heat Transfer*, CRC Press, Boca Raton, FL, 1994.**

Due to Ozisik's clarity and beautifully written mathematics, any of his books are appreciably admired on my bookshelves. Since my research interests surround numerical methods and partial differential equations in engineering applications, this book is one that I would fully utilize.

5. **F.J. Sayas, T.S. Brown, and M.E. Hassell, *Variational Techniques for Elliptic Partial Differential Equations*, CRC Press, Boca Raton, FL, 2019.**

This was the last book my late professor, Francisco-Javier Sayas, published before he died, and as with my copy of his first book, I feel it belongs on my bookshelf next to the first. Professor Sayas told me this book is to be considered an accumulation of his lecture notes from over the decades, "final lectures" so to speak; not yet in my collection, this book already holds immeasurable personal meaning.