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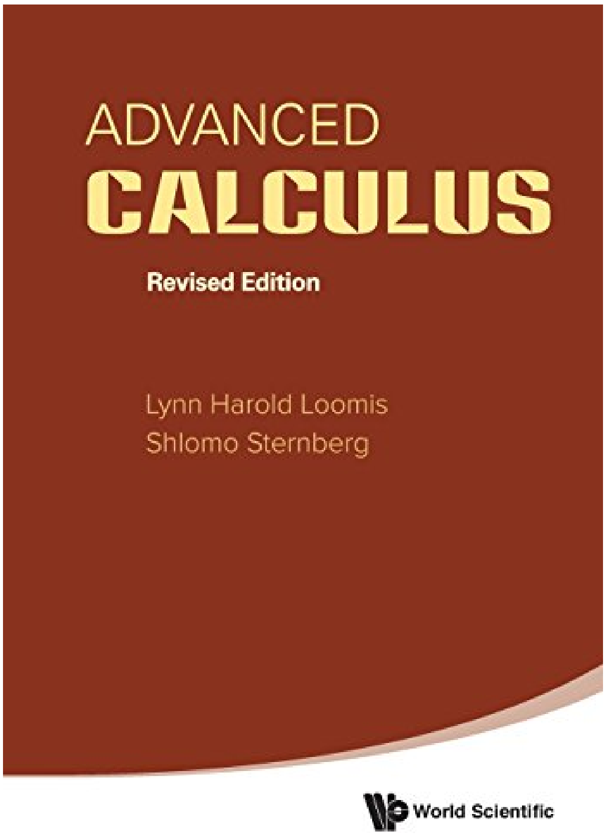

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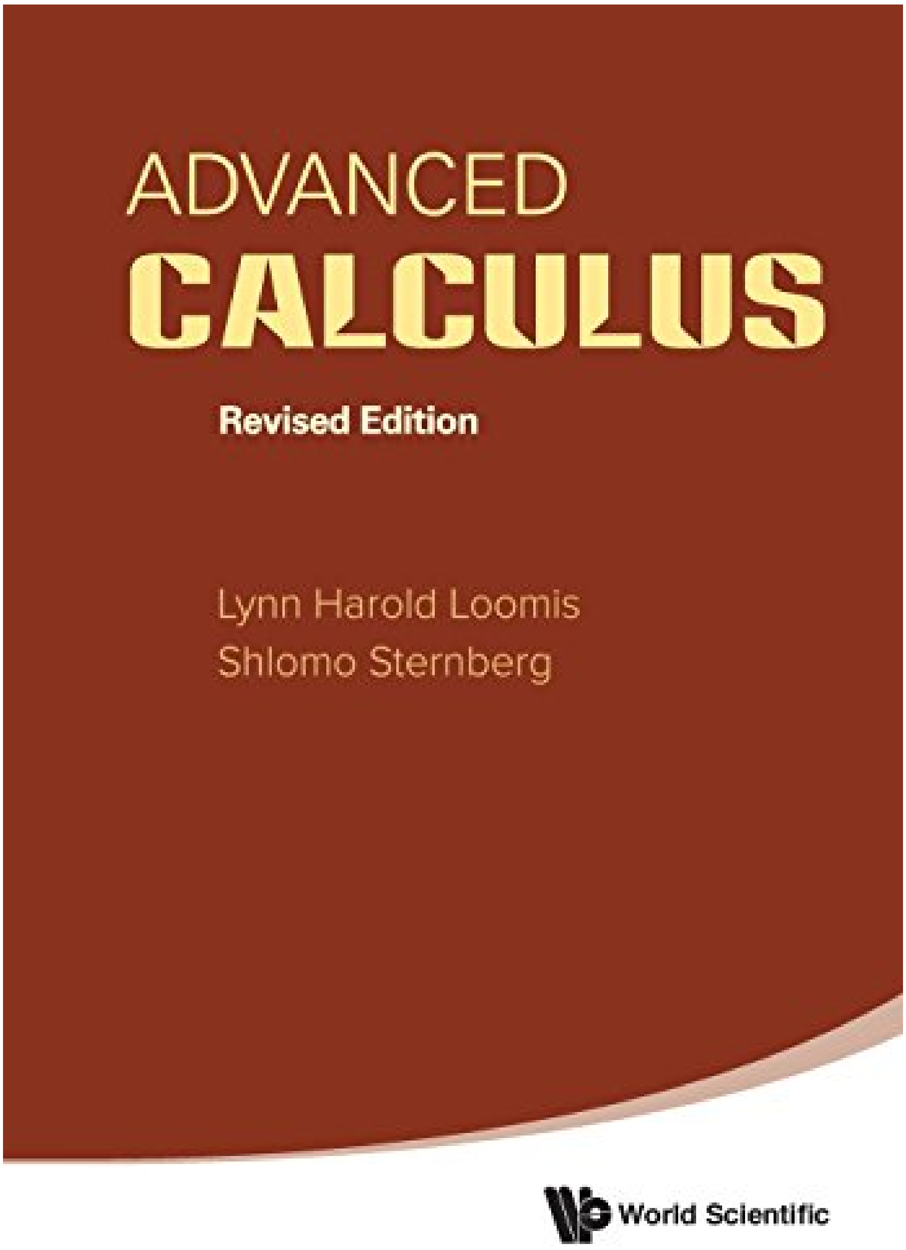
ADVANCED
CALCULUS
Revised Edition
Lynn Harold Loomis
Shlomo Sternberg
World Scientific

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From the Inside Flap
An authorised reissue of the long out of print classic textbook, Advanced Calculus by the late Dr Lynn Loomis and Dr Shlomo Sternberg both of Harvard University has been a revered but hard to find textbook for the advanced calculus course for decades.

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In overall plan the book divides roughly into a first half which develops the calculus (principally the differential calculus) in the setting of normed vector spaces, and a second half which deals with the calculus of differentiable manifolds.

About the Author

Susan Hood is the author of more than 200 children s books, including Leaps and Bounce and Rooting for You (both illustrated by Matthew Cordell); Ada s Violin: The Story of the Recycled Orchestra of Paraguay (illustrated by Sally Wern Comport); and Mission: Back to School (with art by Mary Lundquist), among many others. She has worked as an editor for Nick Jr., Sesame Street, and Scholastic, and when not writing, she enjoys fixing up old houses and sailboats with her husband the original fix-it man! Visit www.susanhoodbooks.com.

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Readership: Undergraduates in mathematics.

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35 of 36 people found the following review helpful.
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By Deucalion
In my opinion, this is the best book on the calculus of product spaces and differentiable manifolds. The exposition is deep, elegant, even magisterial; at the same time, it's unstintingly precise and clear without becoming boring.

Why add another 5-start review to those already here? Because I believe this book should be back in print and used more in courses, and to these ends I wanted to explain what differentiates it from its competitors (Spivak's "Calculus on Manifolds" and Munkres's "Analysis on Manifolds".)

The approach is resolutely modern and "high-tech" but always very accessible and without arbitrary generalization (no modules over commutative rings here, just real and complex vector spaces). Unlike Munkres or Spivak, L&S don't hesitate to develop machinery even when it's not strictly needed to rush headlong to Stokes' Theorem. This makes it a bit hard to use as a supplement unless you are willing to learn the relevant (multi-)linear algebra, Banach space theory, &c. On the other hand, you'll need this stuff to study more mathematics anyway, and it's more complete and useful as a reference once you can read it. In addition to the titular material and many interesting applications, half of basic linear algebra and single-variable calculus is packed in here. I can see instructors being intimidated by the page count (567, vs. 380 for Munkres), but much of it (metric spaces, linear algebra) would be review, albeit high-tech, for many audiences or is optional (mechanics, differential equations).

Chapter 0 is an elegant review of some basics of sets and functions, with a good treatment of duality and indexed sets and products.

Chapters 1 and 2 (together with chapter 5) constitute an excellent linear algebra course (but no canonical forms). While technically requiring no prerequisites (single-variable calculus is needed in a few of the plentiful exercises), the treatment is sophisticated: universal properties and categories are only hinted at, but there is a strong focus on product and direct sum spaces and their associated projection and injection maps, spaces of linear maps, dual spaces, bilinearity, and other "sophisticated" ideas. Throughout the book, but in these chapters especially, the authors are almost heroically careful to avoid any kind of carelessness. They point out when trivial injections are needed because the codomain is part of the data carried by a function, explain what an ordered basis really is, and so on. Occasionally, they omit this care initially before returning to highlight and repair their sloppiness or inviting the student to do so.

In chapter 3, the authors review limits on the real line in order to motivate the introduction of normed linear spaces. After proving (or leaving as exercises) all the standard limit theorems in this context, the authors introduce the notion of "infinitesimals", which, in contrast to those in non-standard (or non-rigorous) analysis books, are defined as (equivalence classes of) functions with certain limiting behaviour at a point. In proving results (the "Oo-theorem") about these functions, the authors "encapsulate" several "epsilon-delta"-type arguments into conveniently re-usable forms. The differential of a function is defined as a bounded linear map such that the remainder term is "little-o". Standard theorems about the differential are now trivial - the composite-function rule is proved in six easy equalities and one sentence (Munkres, by contrast, essentially inlines parts of the "Oo-theorem" into his proof). The authors study directional derivatives and "partial differentials" in arbitrary normed spaces and product spaces before specializing to R^n. Chapter 3 concludes with applications - the general Taylor formula, maximization, Lagrange multipliers, and the calculus of variations.

Chapter 4 is aptly titled "Compactness and Completeness". After a complete review of metric spaces, we return to spaces with a norm, and the rest of the chapter is a tour de force in the striking (and essential!) applications of completeness in this setting: the usual theorems on power series, now proved for arbitrary Banach algebras; the contraction mapping theorem and, as a consequence, the implicit-function theorem; the construction of the Riemann integral (into an arbitrary Banach space) obtained by completing the space of step functions; the fundamental theorem of calculus; some basics of weak methods ...

Chapter 5 covers inner-product spaces and self-adjoint operators. The treatment here is more sophisticated than in elementary linear algebra books since the authors, when possible, don't assume that all spaces are finite-dimensional.

Chapter 6 is a rigorous short course on differential equations. Only the fundamental theorem is needed for the rest of the book, but the technical machinery available at this point is substantially more than in today's elementary ODE texts, and would be a shame to waste.

Chapter 7 is a brief but sophisticated treatment of multilinear algebra. As is common outside graduate algebra texts, the tensor product is defined in terms of linear functionals rather than constructed abstractly.

Chapter 8 is a (mercifully brief) treatment of Riemann integration in R^n. Instead of defining the integral via Darboux sums, L&S define (Jordan) content of sets in R^n, and define integrable functions via approximation, in the spirit of Chapter 4. This highlights the similarity between the Riemann integral and Lebesgue's theory (which isn't covered). There's an optional extended exercise on the Fourier transform.

Chapters 9-11 are the heart of the book: at long last, we define differentiable (Banach!) manifolds. This is done "abstractly", in contrast to Spivak, where manifolds are a subset of R^n, and Munkres, where the more general definition appears only in the prologue ("Life outside R^n"). The content is "standard": flows, vector fields, Lie derivatives, Riemannian metrics, integration, Stokes' Theorem and corollaries. The last two chapters (12,13) are optional, and cover potential theory and classical mechanics (specialties of the respective authors). Covering these in a year-long course would be virtually impossible.

My only complaint is the exercises: chapters 7 and 9-11, which are really crucial, have too few, and those in the earlier chapters, while plentiful, relevant, and insightful, are mostly a bit too easy. Regardless: a desert island text. $\aleph_0$ stars.

29 of 34 people found the following review helpful.
Modest title
By Bernardo Vargas
As Spivak's "Calculus on Manifolds", this book is labeled with a very modest title. It should be something as "All you wanted to know about analysis on manifolds but were afraid to ask".
This book is a must-reading for the analyst. It covers everything from the most basic vector space concepts up to the fundamental theorems of classical mechanics, running through multivariate calculus, exterior calculus, integration of forms, and many topics more, always keeping a very modern and rigorous style.
The undergraduate may find it a little difficult, but the effort is worth it. For the graduate student and the working mathematician it is an almost-daily reference.

12 of 13 people found the following review helpful.
Beautiful book on vector spaces calculus
By A Customer
This book is an amazing work of general vector spaces calculus. From the beginning explaining the foundations of vector spaces up to the classical mechanics mathematical theory (which subject it devotes a seventy-page chapter), treating such things as calculus on manifolds, this book plenty of good exercises has a strong and rigorous text on theory and, along with Michael Spivak's Calculus, is among the finest books ever written on the subject.

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