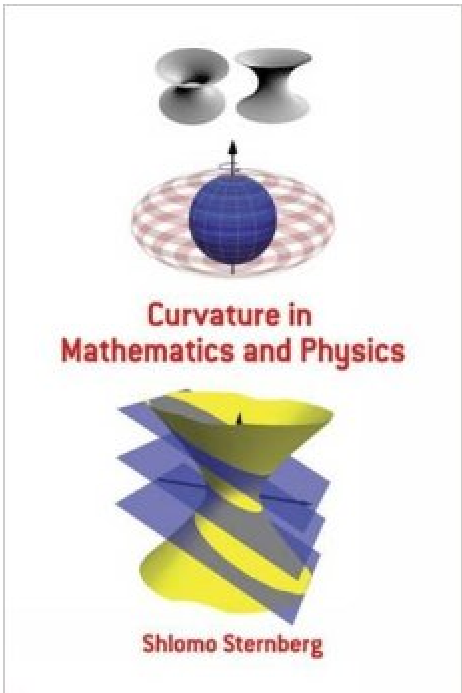
Curvature In Mathematics And Physics (Dover Books On Mathematics)



Synopsis

This original text for courses in differential geometry is geared toward advanced undergraduate and graduate majors in math and physics. Based on an advanced class taught by a world-renowned mathematician for more thanÂ fifty years, the treatment introduces semi-Riemannian geometry and its principal physical application, Einstein’s theory of general relativity, using the Cartan exterior calculus as a principal tool.Starting with an introduction to the various curvatures associated to a hypersurface embedded in Euclidean space, the text advances to a brief review of the differential and integral calculus on manifolds. A discussion of the fundamental notions of linear connections and their curvatures follows, along with considerations of Levi-Civita’s theorem, bi-invariant metrics on a Lie group, Cartan calculations, Gauss’s lemma, and variational formulas. Additional topics include the Hopf-Rinow, Myer’s, and Frobenius theorems; special and general relativity; connections on principal and associated bundles; the star operator; superconnections; semi-Riemannian submersions; and Petrov types. Prerequisites include linear algebra and advanced calculus, preferably in the language of differential forms.

Book Information

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Customer Reviews

A few reviews here and around the web characterize this as "undergrad." At MIT? If you don’t have STRONG linear algebra and advanced (minimum 3 years) calculus, you’ll be lost by the third chapter.I’m the CTO of Classpros dot com and design math visualizations for Engineering students and this is NOT an undergrad text, unless you’re an EXCEPTIONAL undergrad with a LOT of physics and calc already behind you, as in a senior at a tech college. This is not at all to knock the book, it’s to save purchasers from disappointment when they see the author jumping into Relativity from the viewpoint of Cartan exterior calculus and tensors.That said, this is an EXTRAORDINARY text because differential geometry has become so specialized that few grad students except in limited areas of physics/applied math get to go there. The "expansion" of the field with game programming and sims is a new revolution that is "bringing back" fields as dusty as quaternions and spherical trig (see our article on Wiki on the Lenart Sphere, for example)-- and creating exciting new interest in differential forms and geometry.After reviewing and using half a dozen (rare and old) books on differential geometry, this is the ONE book you must have if you are serious about the field, both for breadth and depth and especially currency. Both the most recent applications and the older physics are covered flawlessly. Also, if this were a Springer text, it would be over $100 at this quality and rarity-- what a bargain from Dover!Several reviewers have noted this text as worth the price even though it is a "classic." Ahem.

While one cannot exactly call this an easy introduction to differential geometry, its many problems and proofs cover such a wide range of topics in the field that when the reader successfully completes it, there is no longer much need for an introductory text -- except as reference.Far more important for me was brushing-up on (and then tightening-up on) both linear algebra and Group Theory, -- at least up through Lie Groups. Breathing space for this was more or less allowed in the problems section at the end of chapter 2. Without this warm-up session, trying to apply Riemann geometry to a Euclidian space in chapter 5 would have amounted to little more than a "distant abstraction."The challenge throughout the book was making the connection in ones mind of the dizzying array of curvatures associated with hyper-surfaces possible to embed in Euclidian space. I finally figured out that doing this through the "Calculus of Manifolds" is what this book was all about, and thus represented the true value of the book?In any case, whether true or not, I was delighted to see both the "Lie Derivation of Vector Fields," and the "Schwarzschild Solution" worked through. Previously I had never seen a proper analysis of the former, and the latter only as "settled formula" -- without ever having seen its derivation.So far, I have completed the book up through chapter 12, more enlightened than frightened.When the masters of a subject (such as Shlomo Sternberg is here) presents his material, there is the natural expectation that the reader is going to have to stretch a bit to keep up.

Although billed as a text for undergraduates, only the best-prepared and exceptional undergraduates are likely to get much out of this book. More realistic preparation would be a good course in modern differential geometry.The book uses the modern definition of "differential manifold" throughout, but I can't find it defined anywhere in the book. The grossly inadequate index contains only 17 items starting with "m" , and these do not include "manifold" ! The closest to a definition seems to be a definition of "parametrized surface" in Chapter 1.I doubt that anyone without a previous acquaintance with differential forms will get much out of this book. Technically, the definitions are given in Chapter 2, but in only a few pages in a very abstract way. Some of that treatment seemed to me downright perverse. For example, the concept of "Lie derivative" of a vector field has a simple geometrical interpretation given in almost all texts. From this follows the related concept of Lie derivative of a differential form field, whose geometrical motivation depends on the previous concept of Lie derivative of a vector field. But Sternberg introduces these concepts "backward" starting with a geometrically unmotivated algebraic definition of Lie derivative of a form field (which relies on the nontrivial Weil formula) and from that produces an algebraic definition of Lie derivative of a vector field. I would be surprised if anyone unfamiliar with the general concept of "Lie derivative" will come away from this discussion with an adequate understanding.That said, there is a lot of value in this book for those already familiar with differential geometry. I enjoyed browsing through it.

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