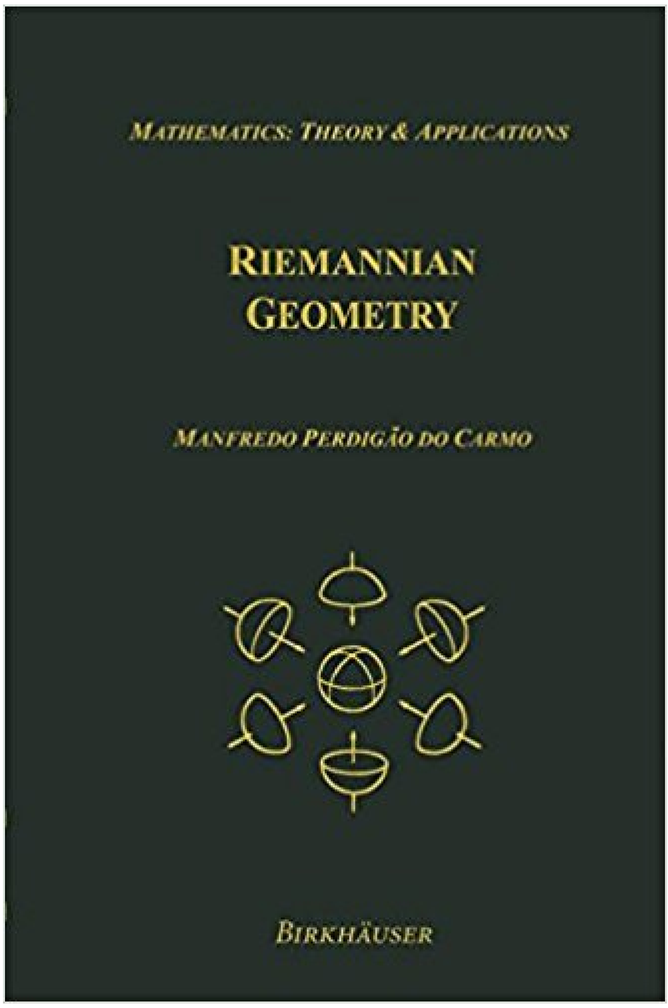
Riemannian Geometry



Synopsis

Riemannian Geometry is an expanded edition of a highly acclaimed and successful textbook (originally published in Portuguese)Ã Â for first-year graduate students in mathematics and physics. The author’s treatment goes very directly to the basic language of Riemannian geometry and immediately presents some of its most fundamental theorems. It is elementary, assuming only a modest background from readers, making it suitable for a wide variety of students and course structures. Its selection of topics has been deemed "superb" by teachers who have used the text. A significant feature of the book is its powerful and revealing structure, beginning simply with the definition of a differentiable manifold and ending with one of the most important results in Riemannian geometry, a proof of the Sphere Theorem. The text abounds with basic definitions and theorems, examples, applications, and numerous exercises to test the student’s understanding and extend knowledge and insight into the subject. Instructors and students alike will find the work to beÃ Â a significant contribution to this highly applicable and stimulating subject.

Book Information

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Customer Reviews

"This is one of the best (if even not just the best) book for those who want to get a good, smooth and quick, but yet thorough introduction to modern Riemannian geometry." Publicationes Mathematicae "This is a very nice introduction to global Riemannian geometry, which leads the reader quickly to the heart of the topic. Nevertheless, classical results are also discussed on many occasions, and almost 60 pages are devoted to exercises." Newsletter of the EMS "In the reviewer's opinion, this is a superb book which makes learning a real pleasure." Revue Romaine de Mathematiques Pures et Appliquees "This mainstream presentation of differential geometry serves well for a course on Riemannian geometry, and it is complemented by many annotated exercises." Monatshefte F. Mathematik"This is one of the best (if even not just the best) book for those who want to get a good, smooth and quick, but yet thorough introduction to modern Riemannian geometry." Publicationes Mathematicae "This is a very nice introduction to global Riemannian geometry, which leads the reader quickly to the heart of the topic. Nevertheless, classical results are also discussed on many occasions, and almost 60 pages are devoted to exercises." Newsletter of the EMS "In the reviewer's opinion, this is a superb book which makes learning a real pleasure." Revue Romaine de Mathematiques Pures et Appliquees "This mainstream presentation of differential geometry serves well for a course on Riemannian geometry, and it is complemented by many annotated exercises." Monatshefte F. Mathematik""This is one of the best (if even not just the best) book for those who want to get a good, smooth and quick, but yet thorough introduction to modern Riemannian geometry." -Publicationes Mathematicae "This is a very nice introduction to global Riemannian geometry, which leads the reader quickly to the heart of the topic. Nevertheless, classical results are also discussed on many occasions, and almost 60 pages are devoted to exercises." -Newsletter of the EMS "In the reviewer's opinion, this is a superb book which makes learning a real pleasure." --Revue Romaine de Mathematiques Pures et Appliquees "This mainstream presentation of differential geometry serves well for a course on Riemannian geometry, and it is complemented by many annotated exercises." --Monatshefte F. Mathematik

Text: English (translation) Original Language: Portugese

Though this text lacks a categorical flavor with commutative diagrams, pull-backs, etc. it is still at an intermediate to advanced level. Nevertheless, constructs are developed which are assumed in a categorical treatment. It does do Hopf-Rinow, Rauch Comparison, and the Morse Index Theorems which you would find in a text like Bishop-Crittendon. However, it does the Sphere Theorem, an advanced theorem dependent on the Morse Theory/calculus of variations methods in differential geometry. Even "energy" is treated which is the kinetic energy functional integral used to determine minimal geodesics, reminiscent of the Maupertuis Principle in mechanics.The reader is assumed to be familiar with differentiable manifolds but a somewhat scant Chapter 0 is given which mostly collects results which will be needed later. The treatment is dominated by the "coordinate-free" approach so emphasis is on the tangent plane or space and properties intrinsic to the surface with only a brief section on tensor methods given. Realize the tangent space has the same dimension as the surface to which it is tangent and this can be greater than 2. If you remember from advanced calculus, you took the gradient of a function of n variables (the function maps to a constant as a sphere say does). The gradient defined the normal to the(n-1) dimensional tangent hyperplane to the surface. The surface is also (n-1) dimensional since given (n-1) values to the variables the nth value is determined by the function equation implicitly. Note in this construction we used the embedding in our interpretation, nevertheless this gradient/tangent hyperplane notion can be given an intrinsically defined method of getting the tangent space through the related notion of the directional derivative. Forging this to a linear tangent space is a key construct which the reader should grasp, one not available in Gauss's lifetime. The text by Boothby is more user-friendly here and is also available online as a free PDF. Boothby essentially covers the first five chapters of do Carmo (including Chapter 0) filling in many of the gaps.Both in Boothby and do Carmo the affine connection makes appearance axiomatically and the covariant derivative results from imposed conditions in a theorem construct. If this is a bit hard to chew (it was for me) there are exercises 1 and 2 on pp. 56-57 of do Carmo in which you are to show how the affine connection and covariant derivative arise from parallel transport. Theorem 3.12 of Chapter VII in Boothby does this a bit too formally but you can find it in various forms on the web. In particular there is a nice one where the tangent planes are related along the curve over which the parallel transport or propagation occurs resulting in a differential equation which gives both the affine connection and the covariant derivative. Just Google "parallel transport and covariant derivative."I have certain quibbles like in defining the Riemannian metric as a bilinear symmetric form,i.e., his notation is a bit dated here and there but the text shines from chapter 5 on. So 5 stars.P.S. There's a PDF entitled "An Introduction to Riemannian Geometry" by Sigmundur Gudmundsson which is free and short and is tailor made for do Carmo assuming only advanced calculus as in say rigorous proof of inverse function theorem or the first nine (or ten) chapters of Rudin's Principles 3rd. It does assume some familiarity with differential geometry in R^3 as in do Carmo's earlier text but you can probably fill this in from the web if you're not familiar from past coursework as in vector analysis. Differential manifold and tangent space are clearly developed without the topological detours-pretty much if you're familiar with the derivative as a linear map (as in Rudin), you're at the right level. Also Lang's "Introduction to Differentiable Manifolds" is available as a free PDF if you want to see the categorical treatment after you get through do Carmo-can also be used for reference concurrently, example-isomorphic linear spaces?

This is a concise, and instructive book that can be read easily.However, this is not for the absolute beginner. Let me explain what kinds of knowledge you should have before digging into this book. You should already be familiar with basic smooth manifold theory found in first few chapters of books such as "Introduction to Smooth Manifolds" by John Lee. For example, the author assumes that you already know how to define tangent space using "derivation." He also assumes that you know the precisely how to show maps between two manifolds are smooth using the coordinate presentation of the map. He also assumes you know tensors. He won't really distinguish coordinate presentation vs the actual map because these are all assumed to be already mastered by the reader.Also, you have to be able to understand his notation from the proof. He has his own set of notations without explanation. Once you read the proof, its meaning becomes clear but this won't happen unless you have some knowledge in smooth manifold theory.With all these prerequisite, reading should be smooth and fun. I sometimes wished he had more pictures but it's not to the level that bothers me. Overall, great book to read on your own!

Classics but not for beginner.

if you are study in riemannian geometry this book is a good textbook for you!before study you should learn some Functions of several variables

This is another well-written text by Do Carmo. I browsed through it and found I could not understand several passages because I did not know what the special symbols meant and there was no table of symbols. I plead with the publisher to add such a table to the next edition or printing.

good

The learning curve for this text is pretty steep if you do not have some decent exposure to differential geometry. While it does a remarkable job at introducing the basic language of Riemannian geometry, it is only ÃƒÂ¢Ã â ¬Ã Å“advancedÃƒÂ¢Ã â ¬Ã Â• in the sense that prior study is required. As mentioned in the text, Riemannian geometry was a natural development of the differential geometry of surfaces in R3. The author does recall some familiar topics in the preliminary exercises (product manifold, embedding of the Klein bottle in R4, the orientable double covering etc.) that give you an idea of what is expected from this course. So, perhaps you are well versed in writing formal proofs that show, for instance, why the MÃƒÂ¶bius band is non-orientable ÃƒÂ¢Ã Â â ¬Ã Â â • but that was then. Now, you will be expected to show that the projective plane P2(R) is non-orientable by first proving that if the manifold M is orientable, then any open subset of M is an orientable submanifold (observe that P2(R) contains an open subset diffeomorphic to a MÃƒÂ¶bius band).Note that the purpose of such exercises is to simply highlight some important results on differentiable manifolds that are necessary in order to proceed with the following chapters on Riemann geometry including Riemannian- metrics, connections, geodesics and curvature. Jacobi fields are introduced in chapter 5 in order to formalize the velocity of the deviation of the geodesic (in previous sections, you will see that the curvature determines how fast the geodesics spread apart). The chapter on isometric immersions is critical in understanding how the Gauss formula generalizes the fundamental theorem of Gauss, which the author describes as the point of departure for Riemannian geometry and even goes so far as to provide a geometric interpretation of the sectional curvature that is essentially the definition of curvature used by Riemann. This chapter concludes with an introduction to the equations of Codazzi and Ricci that are accompanied by GaussÃƒÂ¢Ã Â â ¬Ã Â â„¢ equation to form the fundamental equations of the local theory of isometric immersions.While a little over half the book discusses local properties of Riemannian manifolds, chapter 7 introduces the interplay that exists between the local and global properties of a Riemannian manifold. This section first defines these global properties (i.e. a complete Riemannian manifold M, as a manifold in which the geodesics are defined for all values of their parameter), which transitions nicely into the Theorem of Hopf and Rinow. The remainder of the book introduces more sophisticated notions in Riemannian geometry (i.e. spaces of constant curvature, variations of energy, the Rauch comparison theorem, the Morse index theorem etc.) that allow the reader to develop their own unique interest within this field of study. No doubt these chapters are indispensable and allow this text in particular to become a classical reference to the material.

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