

Preface

Applied Differential Geometry: A Modern Introduction is a graduate-level monographic textbook. It is designed as a comprehensive introduction into methods and techniques of modern differential geometry with its various physical and non-physical applications. In some sense, it is a continuation of our previous book, *Natural Biodynamics* (World Scientific, 2006), which contains all the necessary background for comprehensive reading of the current book. While the previous book was focused on biodynamic applications, the core applications of the new book are in the realm of modern theoretical physics, mainly following its central line: *Einstein–Feynman–Witten*. Other applications include (among others): control theory, robotics, neurodynamics, psychodynamics and socio-economical dynamics.

The book has six chapters. Each chapter contains both ‘pure mathematics’ and related ‘applications’ labelled by the word ‘APPLICATION’.

The first chapter provides a soft (‘plain-English’) introduction into manifolds and related geometrical structures, for all the interested readers without the necessary background. As a ‘snap-shot’ illustration, at the end of the first chapter, a paradigm of generic differential-geometric modelling is given, which is supposed to fit all above-mentioned applications.

The second chapter gives technical preliminaries for development of the modern applied differential geometry. These preliminaries include: (i) classical geometrical objects – *tensors*, (ii) both classical and modern physical objects – *actions*, and modern geometrical objects – *functors*.

The third chapter develops modern *manifold geometry*, together with its main physical and non-physical applications. This chapter is a necessary background for comprehensive reading of the remaining chapters.

The fourth chapter develops modern *bundle geometry*, together with its main physical and non-physical applications.

The fifth chapter develops modern *jet bundle geometry*, together with its main applications in non-autonomous mechanics and field physics. All material in this chapter is based on the previous chapter.

The sixth chapter develops modern geometrical machinery of Feynman's *path integrals*, together with their various physical and non-physical applications. For most of this chapter, only the third chapter is a necessary background, assuming a basic understanding of quantum mechanics (as provided in the above-mentioned World Scientific book, *Natural Dynamics*).

The book contains both an extensive Index (which allows easy connections between related topics) and a number of cited references related to modern applied differential geometry.

Our approach to dynamics of complex systems is somewhat similar to the approach to mathematical physics used at the beginning of the 20th Century by the two leading mathematicians: David Hilbert and John von Neumann – the approach of combining mathematical rigor with conceptual clarity, or *geometrical intuition* that underpins the rigor.

The intended audience includes (but is not restricted to) theoretical and mathematical physicists; applied and pure mathematicians; control, robotics and mechatronics engineers; computer and neural scientists; mathematically strong chemists, biologists, psychologists, sociologists and economists – both in academia and industry.

Compared to all differential-geometric books published so far, *Applied Differential Geometry: A Modern Introduction* has much wider variety of both physical and non-physical applications. After comprehensive reading of this book, a reader should be able to both *read* and *write* journal papers in such diverse fields as superstring & topological quantum field theory, nonlinear dynamics & control, robotics, biomechanics, neurodynamics, psychodynamics and socio-economical dynamics.

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