Lee, Taeyoung; Leok, Melvin; McClamroch, N. Harris
Global formulations of Lagrangian and Hamiltonian dynamics on manifolds. A geometric approach to modeling and analysis. (English) [Zbl 1381.70005]

The starting point of this impressive textbook is the important fact that there are remarkable situations where the variables that describe a dynamical system do not lie in a vector space (i.e., a simple flat algebraic structure) but rather lie in a geometrical setting allowing the differential calculus, namely a differential manifold.

The first chapter presents the necessary mathematical background. The second chapter concerns kinematics. Chapter 3 deals with classical Lagrangian and Hamiltonian mechanics (here classical refers to the Euclidean space $\mathbb{R}^n$). Starting with Chapter 4 the curved framework is considered. Chapter 4 is devoted to $(S^1)^n$, Chapter 5 to $(S^2)^n$, Chapter 6 to the Lie group $SO(3)$ and Chapter 7 to the Lie group $SE(3)$. Having these settings at hand, Chapter 8 is devoted to the general Lagrangian and Hamiltonian dynamics on manifolds. Chapter 9 turns to the rigid and multi-body systems while the last chapter concerns with deformable multi-body systems. There are two appendices: “Fundamental lemmas of the calculus of variations” and “Linearization as an approximation to Lagrangian dynamics on a manifold”. Each chapter ends with problems and exercises.

In conclusion, this book is extremely useful for each reader who wishes to develop a modern knowledge of analytical mechanics.

Reviewer: Mircea Crâsmăreanu (Iaşi)

MSC:

70-02 Research exposition (monographs, survey articles) pertaining to mechanics of particles and systems
37-02 Research exposition (monographs, survey articles) pertaining to dynamical systems and ergodic theory
37Jxx Dynamical aspects of finite-dimensional Hamiltonian and Lagrangian systems
70Hxx Hamiltonian and Lagrangian mechanics

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