Preface

This book evolved from my occasional teaching of graduate Classical Mechanics at Boston University.

In the late 1960's I recommended the well-known texts by H. Goldstein, L.D. Landau and E.M. Lifshitz (?), and A. Sommerfeld. In the late 1980's I learned some modern differential geometry while catching up with gauge field theory. Thus I became able to appreciate the elegance of V.I. Arnold's *Mathematical Methods of Classical Mechanics.*

I took the educational risk of presenting Hamiltonian mechanics expressed in Cartan's notation as a kind of appendix following the traditional treatment. Instructors in other universities also seem to have recognized that the graduate teaching of classical mechanics in physics departments should be updated. In this book I have tried to satisfy both traditionalists and modernists by approaching each subject at successive levels of abstraction.

My work is designed for a first-year physics graduate student at Boston University, who has taken "Intermediate Mechanics". Knowledge of curvilinear coordinates, vector analysis, advanced calculus etc. is assumed. The wealth of detail offered should not lull the reader into thinking that the material can be learned by leafing through the book. As much time as possible should be devoted to going through the calculations and solving problems.

Chapter 1 is an introduction meant to establish a rapport between the reader and my way of presenting the material. Chapter 2 builds up a stock of formulae to be drawn from in later chapters. Chapter 3 is mostly devoted to oscillations. It ends with a sketchy account of chaos for discrete maps to introduce the reader to a field founded a century ago by Poincaré and cultivated intensively in recent years.

Chapters 4 and 5 cover coordinate systems, inertial forces, and rigid bodies.

Analytical mechanics begins with chapter 6, Lagrangians. Problems already worked out in previous chapters are again solved by using Lagrangian methods. The reader is invited to compare the amount of labor involved in the two versions.

Chapter 7 presents Hamiltonian mechanics. Sections 7.1 to 7.4 give a simple account of the traditional treatment. Section 7.5 introduces Cartan's notation, which is used throughout the following sections as well as in chapter 8, action-angle variables and adiabatic invariants.

Chapter 9 is on classical perturbation theory with emphasis on the similarity with the perturbation theory of quantum mechanics and field theory.

Relativistic dynamics is discussed in chapter 10, with attention to the "spinor connection", the spin, and the Thomas precession.

Chapter 11 illustrates Lagrangian and Hamiltonian methods for continuous systems by discussing two case studies, the vibrating string and the ideal incompressible non-viscous fluid. The Lagrangian description of the latter is not widely known. I worked unsuccessfully trying to formulate it, until I was lucky enough to find D.E. Soper's *Classical Field Theory* and reference to the original 1911 paper by G. Herglotz.

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In addition to the books mentioned in the Preface I learned from many others, but I wish to mention J.D. Jackson *Classical Electrodynamics*, C.W. Kilmister and J.E. Reeves *Rational Mechanics*, R.A. Mann *The Classical Dynamics of Particles - Galilean and Lorentz relativity*, B.F. Schutz *Geometrical methods of mathematical physics*, W.Thirring *Classical Dynamical Systems.*

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