A Student’s Guide to Lagrangians and Hamiltonians

A concise but rigorous treatment of variational techniques, focusing primarily on Lagrangian and Hamiltonian systems, this book is ideal for physics, engineering and mathematics students.

The book begins by applying Lagrange’s equations to a number of mechanical systems. It introduces the concepts of generalized coordinates and generalized momentum. Following this, the book turns to the calculus of variations to derive the Euler–Lagrange equations. It introduces Hamilton’s principle and uses this throughout the book to derive further results. The Hamiltonian, Hamilton’s equations, canonical transformations, Poisson brackets and Hamilton–Jacobi theory are considered next. The book concludes by discussing continuous Lagrangians and Hamiltonians and how they are related to field theory.

Written in clear, simple language, and featuring numerous worked examples and exercises to help students master the material, this book is a valuable supplement to courses in mechanics.

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Introduction

The purpose of this book is to give the student of physics a basic overview of Lagrangians and Hamiltonians. We will focus on what are called variational techniques in mechanics. The material discussed here includes only topics directly related to the Lagrangian and Hamiltonian techniques. It is not a traditional graduate mechanics text and does not include many topics covered in texts such as those by Goldstein, Fetter and Walecka, or Landau and Lifshitz. To help you to understand the material, I have included a large number of easy exercises and a smaller number of difficult problems. Some of the exercises border on the trivial, and are included only to help you to focus on an equation or a concept. If you work through the exercises, you will better prepared to solve the difficult problems. I have also included a number of worked examples. You may find it helpful to go through them carefully, step by step.

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