<<非线性变形体动力学>>

图书基本信息

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前言

Deformable-body dynamics is a subject to investigate the states of strains and internal relative motions in deformable solids subject to the action of external forces. This is an old and interesting topic, and many problems still are unsolved or solved incompletely. Rethinking such problems in this topic may bring new vital to the modem science and technology. The first consideration of the nature of the resistance of deformable-bodies to rupture was given by Galileo in 1638. The theory of deformable-bodies, started from Galileo's problem, is based on the discovery of Hooke's Law in 1660 and the general differential equations of elasticity by Navier in 1821. The Hooke's law is an experimental discovery about the stress and strain relation. This law provides the basis to develop the mathematical theory of deformable bodies. In 1821, Navier was the first to investigate the general equations of equilibrium and vibration of elastic solids. In 1850, Kirchhoff proposed two assumptions: (i) that linear filaments of the plate initially normal to the middle-surface remain straight and normal to the middle-surface after deformed, and (ii) that all fibers in middle surface remain unstretched. Based on the Kirchhoff assumptions, the approximate theories for beams, rods, plates and shells have been developed for recent 150 years. From the theory of 3-dimensional deformable body, with certain assumptions, this book will present a mathematical treatise of such approximate theories for thin deformable-bodies including cables, beams, rods, webs, membranes, plates and shells. The nonlinear theory for deformable body based on the Kirchhoff assumptions is a special case to be discussed. This book consists of eight chapters. Chapter 1 discusses the history of the deformable body dynamics. Chapter 2 presents the mathematical tool for the de-formation and kinematics of deformable-bodies. Chapter 3 addresses the deformation geometry, kinematics and dynamics of deformable body. Chapter 4 discusses constitutive laws and damage theory for deformable-bodies. In Chapter 5, nonlinear dynamics of cables is addressed. Chapter 6 discusses nonlinear plates and waves, and the nonlinear theories for webs, membranes and shells are presented in Chapter 7. Finally, Chapter 8 presents the nonlinear theory for thin beams and rods.

内容概要

Nonlinear Deformable-body Dynamics mainly consists in a mathematical treatise of approximate theories for thin deformable bodies, including cables, beams, rods, webs, membranes, plates, and shells. The intent of the book is to stimulate more researches in the area of nonlinear deformable-body dynamics not only because of the unsolved theoretical puzzles it presents but also because of its wide spectrum of applications. For instance, the theories for soft webs and rod-reinforced soft structures can be applied to biomechanics for DNA and living tissues, and the nonlinear theory of deformable bodies, based on the Kirchhoffassumptions, is a special case discussed. This book can serve as a reference work for researchers and a textbook for senior and postgraduate students in physics, mathematics, engineering and biophysics.

作者简介

Dr. Albert C.J. Luo is a Professor of Mechanical Engineering at Southern Illinois University, Edwardsville, IL, USA. Professor Luo is an internationally recognized scientist in the field of nonlinear dynamics in dynamical systems and deformable solids.

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章节摘录

插图：This book consists of eight chapters. Chapter 1 discusses the history of the deformable body dynamics. In Chapter 2, the mathematical tool for the deformation and kinematics of the deformable bodies will be presented. Chapter 3 will address the deformation geometry, kinematics and dynamics of deformable bodies. Chapter 4 will present constitutive laws and damage theory for deformable bodies. In Chapter 5, nonlinear cable dynamics will be presented. Chapter 6 will discuss the nonlinear theory and vibration waves of plates. In Chapter 7, the nonlinear theory for webs, membranes and shells will be presented. Finally, Chapter 8 will present the nonlinear theory for beams and rods. The main contents in this book are summarized as follows.Chapter 2 will review the basic vector algebra first. The base vectors and metric tensors will be introduced, and the local base vectors in curvilinear coordinates and tensor algebra will be presented. The second-order tensors will be discussed in detail. The differentiation and derivatives of tensor fields will be presented, and the gradient, invariant differential operators and integral theorems for tensors are presented. The Riemann-Christoffel curvature tensor will also be discussed. Finally, two-point tensor fields will be presented.Chapter 3 will present the deformation geometry, kinematics and dynamics of continuous media. To discuss deformation geometry, the deformation gradients will be introduced in the local curvilinear coordinate systems, and the Green and Cauchy strain tensors will be presented. The stretch and angle changes for line elements will be discussed through Green and Cauchy strain tensors. The velocity gradient will be introduced for kinematics, and the material derivatives of deformation gradient, infinitesimal line element, area and volume in the deformed configuration will be presented.

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