

# Mathematical Theory of Dislocations and Fracture

R. W. LARDNER



# Mathematical Theory Of Dislocations And Fracture

**Carlo Sansour, Sebastian Skatulla**



## **Mathematical Theory Of Dislocations And Fracture:**

**Mathematical Theory of Dislocations and Fracture** R. W. Lardner, 1974 Concise logical and mathematically rigorous this introduction to the theory of dislocations is addressed primarily to students and researchers in the general areas of mechanics and applied mathematics Its scope encompasses those aspects of dislocation theory which are closely related to the theories of elasticity and macroscopic plasticity to modern continuum mechanics and to the theory of cracks and fracture The volume incorporates several new and original pieces of work including a development of the theory of dislocation motion and plastic strain for non linear materials a new discussion of the line tension model revised calculations of the Peierls resistance and a new development of the van der Merwe theory of crystal interfaces      **Theory of Dislocations** Peter M. Anderson, John P. Hirth, Jens Lothe, 2017-01-16 Theory of Dislocations provides unparalleled coverage of the fundamentals of dislocation theory with applications to specific metal and ionic crystals Rather than citing final results step by step developments are provided to offer an in depth understanding of the topic The text provides the solid theoretical foundation for researchers to develop modeling and computational approaches to discrete dislocation plasticity yet it covers important experimental observations related to the effects of crystal structure temperature nucleation mechanisms and specific systems This new edition incorporates significant advances in theory experimental observations of dislocations and new findings from first principles and atomistic treatments of dislocations Also included are new discussions on thin films deformation in nanostructured systems and connection to crystal plasticity and strain gradient continuum formulations Several new computer programs and worked problems allow the reader to understand visualize and implement dislocation theory concepts      *Mathematical Theory of Dislocations* Toshio Mura, 1969      *Theory of Electroelasticity* Zhen-Bang Kuang, 2013-08-04 Theory of Electroelasticity analyzes the stress strain electric field and electric displacement in electroelastic structures such as sensors actuators and other smart materials and structures This book also describes new theories such as the physical variational principle and the inertial entropy theory It differs from the traditional method by using the physical variational principle to derive the governing equations of the piezoelectric material whereas the Maxwell stress is obtained automatically By using the inertial entropy theory the temperature wave equation is obtained very easily The book is intended for scientists researchers and engineers in the areas of mechanics physics smart material and control engineering as well as mechanical aeronautical and civil engineering etc Zhen Bang Kuang is a professor at Shanghai Jiao Tong University      [Introduction to Dislocations](#) Derek Hull, D. J. Bacon, 2011-02-18 In materials science dislocations are irregularities within the crystal structure or atomic scale of engineering materials such as metals semi conductors polymers and composites Discussing this specific aspect of materials science and engineering Introduction to Dislocations is a key resource for students The book provides students and practitioners with the fundamental principles required to understand dislocations Comprised of 10 chapters the text includes advanced computer modeling and very high resolution electron

microscopy to help readers better understand the structure of atoms close to the core of dislocations It shows that atomic arrangement has a significant effect on the formation of dislocations and thereby on the properties of solids The first two chapters of the book present an overview of dislocations The crystal structures and the various defects and dislocations are discussed and methods of observation and diagnosis of dislocations are covered Chapters 3 to 5 discuss the behavior of dislocations and explain how changes in the structure and arrangement of atoms can affect the behavior of dislocations The three chapters also discuss the mechanical properties of dislocations The remaining chapters offer a detailed discussion of the mechanisms of dislocations and the mechanical strength of crystalline solids The book is written for undergraduate and graduate level students in both materials science and mechanical engineering Non experts and novices working on mechanical properties mechanisms of deformation and fracture and properties of materials as well as industrial and academic researchers will find this book invaluable Long established academic reference by an expert author team highly regarded for their contributions to the field Uses minimal mathematics to present theory and applications in a detailed yet easy to read manner making this an understandable introduction to a complex topic Unlike the main competition this new edition includes recent developments in the subject and up to date references to further reading and research sources

**Continuum Mechanics - Volume III** José Merodio, Giuseppe Saccomandi, 2011-11-30 The main objective of continuum mechanics is to predict the response of a body that is under the action of external and or internal influences i e to capture and describe different mechanisms associated with the motion of a body that is under the action of loading A body in continuum mechanics is considered to be matter continuously distributed in space Hence no attention is given to the microscopic atomic structure of real materials although non classical generalized theories of continuum mechanics are able to deal with the mesoscopic structure of matter i e defects cracks dispersive lengths Matter occupies space in time and the response of a body in continuum mechanics is restricted to the Newtonian space time of classical mechanics in this volume Einstein s theory of relativity is not considered In the classical sense loading is considered as any action that changes the motion of the body This includes for instance a change in temperature or a force applied By introducing the concept of configurational forces a load may also be considered as a force that drives a change in the material space for example the opening of a crack Continuum mechanics refers to field descriptions of phenomena that are usually modeled by partial differential equations and from a mathematical point of view require non standard knowledge of non simple technicalities One purpose in this volume has been to present the different subjects in a self contained way for a general audience The organization of the volume is as follows Mathematically to predict the response of a body it is necessary to formulate boundary value problems governed by balance laws The theme of the volume that is an overview of the subject has been written with this idea in mind for beginners in the topic Chapter 1 is an introduction to continuum mechanics based on a one dimensional framework in which simultaneously a more detailed organization of the chapters of this volume is given A one

dimensional approach to continuum mechanics in some aspects maybe misleading since the analysis is oversimplified Nevertheless it allows us to introduce the subject through the early basic steps of the continuum analysis for a general audience Chapters 3 4 and 5 are devoted to the mathematical setting of continuum analysis kinematics balance laws and thermodynamics respectively Chapters 6 and 7 are devoted to constitutive equations Chapters 8 and 9 deal with different issues in the context of linear elastostatics and linear elastodynamics and waves respectively for solids Linear Elasticity is a classical and central theory of continuum mechanics Chapter 10 deals with fluids while chapter 11 analyzes the coupled theory of thermoelasticity Chapter 12 deals with nonlinear elasticity and its role in the continuum framework Chapters 13 and 14 are dedicated to different applications of solid and fluid mechanics respectively The rest of the chapters involve some advanced topics Chapter 15 is dedicated to turbulence one of the main challenges in fluid mechanics Chapter 16 deals with electro magneto active materials a coupled theory Chapter 17 deals with specific ideas of soft matter and chapter 18 deals with configurational forces In chapter 19 constitutive equations are introduced in a general implicit form Well posedness existence time of existence uniqueness continuity of the equations of the mechanics of continua is an important topic which involves sophisticated mathematical machinery Chapter 20 presents different analyses related to these topics Continuum Mechanics is an interdisciplinary subject that attracts the attention of engineers mathematicians physicists etc working in many different disciplines from a purely scientific environment to industrial applications including biology materials science engineering and many other subjects

**Dislocation Modelling of Physical Systems** M.F. Ashby, R. Bullough, C.S. Hartley, 2013-10-22 Dislocation Modelling of Physical Systems contains the Proceedings of the International Conference held at Gainesville Florida USA on June 22 27 1980 The book emphasizes the growing interest in relating dislocation theoretic concepts to engineering problems Topic areas chosen ranged from the fundamental such as properties of single dislocations to the more applied such as fracture The papers are grouped specifically based on the main topics they discuss These topics include fracture point defects and dislocations structure dependence of mechanical behavior properties of single dislocations plasticity and geometry of deformation internal friction effects and boundaries

**Generalized Continua and Dislocation Theory** Carlo Sansour, Sebastian Skatulla, 2012-05-27 Defects dislocations and the general theory Approaches to generalized continua Generalized continuum modelling of crystal plasticity Introduction to discrete dislocation dynamics The book contains four lectures on generalized continua and dislocation theory reflecting the treatment of the subject at different scales G Maugin provides a continuum formulation of defects at the heart of which lies the notion of the material configuration and the material driving forces of in homogeneities such as dislocations disclinations point defects cracks phase transition fronts and shock waves C Sansour and S Skatulla start with a compact treatment of linear transformation groups with subsequent excursion into the continuum theory of generalized continua After a critical assessment a unified framework of the same is presented The next contribution by S Forest gives an account on generalized crystal plasticity

Finally H Zbib provides an account of dislocation dynamics and illustrates its fundamental importance at the smallest scale In three contributions extensive computational results of many examples are presented

**Boundary Value Problems in Linear Viscoelasticity** John M. Golden, George A.C. Graham, 2013-04-17 The classical theories of Linear Elasticity and Newtonian Fluids though triumphantly elegant as mathematical structures do not adequately describe the deformation and flow of most real materials Attempts to characterize the behaviour of real materials under the action of external forces gave rise to the science of Rheology Early rheological studies isolated the phenomena now labelled as viscoelastic Weber 1835 1841 researching the behaviour of silk threads under load noted an instantaneous extension followed by a further extension over a long period of time On removal of the load the original length was eventually recovered He also deduced that the phenomena of stress relaxation and damping of vibrations should occur Later investigators showed that similar effects may be observed in other materials The German school referred to these as Elastische Nachwirkung or the elastic aftereffect while the British school including Lord Kelvin spoke of the viscosity of solids The universal adoption of the term Viscoelasticity intended to convey behaviour combining properties both of a viscous liquid and an elastic solid is of recent origin not being used for example by Love 1934 though Alfrey 1948 uses it in the context of polymers The earliest attempts at mathematically modelling viscoelastic behaviour were those of Maxwell 1867 actually in the context of his work on gases he used this model for calculating the viscosity of a gas and Meyer 1874

**Physics of Elasticity and Crystal Defects** Adrian P. Sutton, 2020-06-25 This textbook is a modern take on an old subject at the heart of materials physics Properties of crystalline materials are almost always controlled by structural defects within them Until relatively recently these defects were studied theoretically using continuum elasticity theory which ignores the atomic structure of the host material This book introduces the concepts of elasticity in the traditional continuum way and also in terms of atomic interactions It goes on to present point impurities missing atoms line dislocations and planar faults cracks defects at both the continuum level and the atomic level This novel approach will be new to most engineers and it will appeal to physicists There are exercises for the student to work through with complete solutions free to course instructors from the OUP website

**Micromechanics of Defects in Solids** T. Mura, 2012-12-06 This book stems from a course on Micromechanics that I started about fifteen years ago at Northwestern University At that time micromechanics was a rather unfamiliar subject Although I repeated the course every year I was never convinced that my notes have quite developed into a final manuscript because new topics emerged constantly requiring revisions and additions I finally came to realize that if this is continued then I will never complete the book to my total satisfaction Meanwhile T Mori and I had coauthored a book in Japanese entitled Micromechanics published by Baifukan Tokyo in 1975 It received an extremely favorable response from students and researchers in Japan This encouraged me to go ahead and publish my course notes in their latest version as this book which contains further development of the subject and is more comprehensive than the one published in Japanese Micromechanics encompasses mechanics related to

microstructures of materials The method employed is a continuum theory of elasticity yet its applications cover a broad area relating to the mechanical behavior of materials plasticity fracture and fatigue constitutive equations composite materials polycrystals etc These subjects are treated in this book by means of a powerful and unified method which is called the eigenstrain method In particular problems relating to inclusions and dislocations are most effectively analyzed by this method and therefore special emphasis is placed on these topics

### **A Course on Plasticity Theory** David J.

Steigmann, 2023-01-05 Plasticity Theory is characterized by many competing and often incompatible points of view This book seeks to strengthen the foundations of continuum plasticity theory emphasizing a unifying perspective grounded in the fundamental notion of material symmetry Steigmann's book offers a systematic framework for the proper understanding of established models of plasticity and for their modern extensions and generalizations Particular emphasis is placed on the differential geometric aspects of the subject and their role in illuminating the conceptual foundations of plasticity theory Classical models together with several subjects of interest in contemporary research are developed in a unified format The book is addressed to graduate students and academics working in the field of continuum mechanics

*Atomic Mechanics of Solids* A.K. Macpherson, 2012-12-02 This volume brings together some of the presently available theoretical techniques which will be useful in the design of solid state materials At present it is impossible to specify the atomic composition of a material and its macroscopic physical properties However the future possibilities for such a science are being laid today This is coming about due to the development of fast cheap computers which will be able to undertake the calculations which are necessary Since this field of science is fairly new it is not yet quite clear which direction of analysis will eventually prove to be the most successful In this respect the author has included the most relevant promising subject areas based on seven years of research experience in the field An extensive literature already exists for most of the areas covered here thus when more detailed analysis can be found elsewhere the assumptions made are discussed and only an outline of the method involved is presented Comprehensive indexes are provided to assist the reader in further studies This is a potentially important field which is slowly getting underway and only needs a significant development to attract a broader scientific interest The work will be of considerable interest to program managers needing to assess this new field

**Micromechanics of defects in solids** Toshio Mura, 2013-03-09 This book stems from a course on Micromechanics that I started about fifteen years ago at Northwestern University At that time micro mechanics was a rather unfamiliar subject Although I repeated the course every year I was never convinced that my notes have quite developed into a final manuscript because new topics emerged constantly requiring revisions and additions I finally came to realize that if this is continued then I will never complete the book to my total satisfaction Meanwhile T Mori and I had coauthored a book in Micromechanics published by Baifukan Tokyo in Japanese entitled 1975 It received an extremely favorable response from students and researchers in Japan This encouraged me to go ahead and publish my course notes in their latest version as this

book which contains further development of the subject and is more comprehensive than the one published in Japanese Micromechanics encompasses mechanics related to microstructures of materials The method employed is a continuum theory of elasticity yet its applications cover a broad area relating to the mechanical behavior of materials plasticity fracture and fatigue constitutive equations composite materials polycrystals etc These subjects are treated in this book by means of a powerful and unified method which is called the eigenstrain method In particular problems relating to inclusions and dislocations are most effectively analyzed by this method and therefore special emphasis is placed on these topics **Gauge**

**Theory and Defects in Solids** D.G.B. Edelen,D.C. Lagoudas,2012-12-02 This new series Mechanics and Physics of Discrete Systems aims to provide a coherent picture of the modern development of discrete physical systems Each volume will offer an orderly perspective of disciplines such as molecular dynamics crystal mechanics and or physics dislocation etc Emphasized in particular are the fundamentals of mechanics and physics that play an essential role in engineering applications Volume 1 Gauge Theory and Defects in Solids presents a detailed development of a rational theory of the dynamics of defects and damage in solids Solutions to field equations are used to determine stresses dislocation densities and currents that arise from histories of loading of boundaries of bodies Analysed in detail is a gauge theory with a gauge group that is not semi simple and whose action occurs at the classical macroscopic level Yang Mills theory is applied where the state variables are elastic displacements in solids determination of mechanical and electromagnetic observables by choice of gauge conditions is demonstrated and practices of classical dislocation theory are derived from first principles **Free**

**Boundary Problems** Isabel Narra Figueiredo,Lisa Santos,2007-01-11 This book collects refereed lectures and communications presented at the Free Boundary Problems Conference FBP2005 These discuss the mathematics of a broad class of models and problems involving nonlinear partial differential equations arising in physics engineering biology and finance Among other topics the talks considered free boundary problems in biomedicine in porous media in thermodynamic modeling in fluid mechanics in image processing in financial mathematics or in computations for inter scale problems

**Mechanics Of Micropolar Media** Olof Brulin,Richard K T Hsieh,1982-01-01 This book is essentially made up of the lecture notes delivered by seven authors at the International Centre for Mechanical Sciences in Udine in June 1979 It attempts to provide an up to date and concise summary of the authors understanding of micropolar materials Both asymmetric elasticity and fluids are covered The chapters range from the discussion of micropolar molecular models to the analysis of structure models from linear to nonlinear theories and from electromagnetic thermal viscous effects to lattice defects The subjects are treated from both theoretical and experimental points of view Students with physics mathematics and mechanical backgrounds as well as professionals will find this treatise useful for study and reference *August 16*

Görllich,2022-01-19 No detailed description available for August 16 Nonlocal Continuum Field Theories A. Cemal Eringen,2007-06-14 Nonlocal continuum field theories are concerned with material bodies whose behavior at any interior

point depends on the state of all other points in the body rather than only on an effective field resulting from these points in addition to its own state and the state of some calculable external field Nonlocal field theory extends classical field theory by describing the responses of points within the medium by functionals rather than functions the constitutive relations of classical field theory Such considerations are already well known in solid state physics where the nonlocal interactions between the atoms are prevalent in determining the properties of the material The tools developed for crystalline materials however do not lend themselves to analyzing amorphous materials or materials in which imperfections are a major part of the structure Nonlocal continuum theories by contrast can describe these materials faithfully at scales down to the lattice parameter This book presents a unified approach to field theories for elastic solids viscous fluids and heat conducting electromagnetic solids and fluids that include nonlocal effects in both space and time memory effects The solutions to the field equations agree remarkably well with atomic theories and experimental observations      **Plasticity S.**

Nemat-Nasser,2004-11-29 Publisher Description

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