

# Introduction To Fracture Mechanics

## Materials Ernet

Fatigue of structures and materials covers a wide scope of different topics. The purpose of the present book is to explain these topics, to indicate how they can be analyzed, and how this can contribute to the designing of fatigue resistant structures and to prevent structural fatigue problems in service. Chapter 1 gives a general survey of the topic with brief comments on the significance of the aspects involved. This serves as a kind of a program for the following chapters. The central issues in this book are predictions of fatigue properties and designing against fatigue. These objectives cannot be realized without a physical and mechanical understanding of all relevant conditions. In Chapter 2 the book starts with basic concepts of what happens in the material of a structure under cyclic loads. It illustrates the large number of variables which can affect fatigue properties and it provides the essential background knowledge for subsequent chapters. Different subjects are presented in the following main parts:

- Basic chapters on fatigue properties and predictions (Chapters 2-8)
- Load spectra

and fatigue under variable-amplitude loading (Chapters 9-11) • Fatigue tests and scatter (Chapters 12 and 13) • Special fatigue conditions (Chapters 14-17) • Fatigue of joints and structures (Chapters 18-20) • Fiber-metal laminates (Chapter 21) Each chapter presents a discussion of a specific subject.

The analysis of crack problems through fracture mechanics has been applied to the study of materials such as glass, metals and ceramics because relatively simple fracture criteria describe the failure of these materials. The increased attention paid to experimental rock fracture mechanics has led to major contributions to the solving of geophysical problems. The text presents a concise treatment of the physics and mathematics of a representative selection of problems from areas such as earthquake mechanics and prediction, hydraulic fracturing, hot dry rock geothermal energy, fault mechanics, and dynamic fragmentation.

Fracture mechanics studies the development and spreading of cracks in materials. The study uses two techniques including analytical and experimental solid mechanics. The former is used to determine the driving force on a crack and the latter is used to measure material's

resistance to fracture. The text begins with a detailed discussion of fundamental concepts including linear elastic fracture mechanics (LEFM), yielding fracture mechanics, mixed mode fracture and computational aspects of linear elastic fracture mechanics. It explains important topics including Griffith theory of brittle crack propagation and its Irwin and Orowan modification, calculation of theoretical cohesive strength of materials through an atomic model and analytical determination of crack tip stress field. This book covers MATLAB programs for calculating fatigue life under variable amplitude cyclic loading. The experimental measurements of fracture toughness parameters K<sub>IC</sub>, J<sub>IC</sub> and crack opening displacement (COD) are provided in the last chapter.

Presenting the most important results, methods, and open questions, this book describes and compares advanced models in fracture mechanics. The author introduces the required mathematical technique, mainly the theory of analytical functions, from scratch.

Introduction to Fracture Mechanics  
Advances in Research on the Strength and Fracture of Materials  
A Solution Guide

## Mechanical Behavior and Fracture of Engineering Materials

Theoretical and experimental study of the mechanical behavior of structures under load

**Analysis of Engineering Structures and Material Behavior** is a textbook covering introductory and advanced topics in structural analysis. It begins with an introduction to the topic, before covering fundamental concepts of stress, strain and information about mechanical testing of materials. Material behaviors, yield criteria and loads imposed on the engineering elements are also discussed. The book then moves on to cover more advanced areas including relationships between stress and strain, rheological models, creep of metallic materials and fracture mechanics. Finally, the finite element method and its applications are considered.

**Key features:** Covers introductory and advanced topics in structural analysis, including load, stress, strain, creep, fatigue and finite element analysis of structural elements. Includes examples and considers mathematical formulations. A pedagogical approach to the topic.

**Analysis of Engineering Structures and Material Behavior** is suitable as a textbook for structural analysis and mechanics courses in structural, civil and mechanical engineering, as well as a valuable guide for practicing engineers.

This book presents recent advances related to the following two topics: how mechanical fields close to material or geometrical singularities such as cracks can be determined; how failure criteria can be established

according to the singularity degrees related to these discontinuities. Concerning the determination of mechanical fields close to a crack tip, the first part of the book presents most of the traditional methods in order to classify them into two major categories. The first is based on the stress field, such as the Airy function, and the second resolves the problem from functions related to displacement fields. Following this, a new method based on the Hamiltonian system is presented in great detail. Local and energetic approaches to fracture are used in order to determine the fracture parameters such as stress intensity factor and energy release rate. The second part of the book describes methodologies to establish the critical fracture loads and the crack growth criteria. Singular fields for homogeneous and non-homogeneous problems near crack tips, v-notches, interfaces, etc. associated with the crack initiation and propagation laws in elastic and elastic-plastic media, allow us to determine the basis of failure criteria. Each phenomenon studied is dealt with according to its conceptual and theoretical modeling, to its use in the criteria of fracture resistance; and finally to its implementation in terms of feasibility and numerical application. Contents 1. Introduction. Part 1: Stress Field Analysis Close to the Crack Tip 2. Review of Continuum Mechanics and the Behavior Laws. 3. Overview of Fracture Mechanics. 4. Fracture Mechanics. 5. Introduction to the Finite Element Analysis of Cracked Structures. Part 2: Crack Growth Criteria 6. Crack Propagation. 7. Crack Growth Prediction in Elements of

Steel Structures Submitted to Fatigue. 8. Potential Use of Crack Propagation Laws in Fatigue Life Design.

BASIC Fracture Mechanics: Including an Introduction to Fatigue discusses the fundamentals of fracture and fatigue. The book presents a series of Beginner's All-purpose Symbolic Instruction Code (BASIC) programs that implement fracture and fatigue methods. The first chapter reviews the BASIC, while the second chapter covers elastic fracture. Chapter 3 deals with the stress intensity factors. The book also tackles the crack tip plasticity and covers crack growth. The last chapter in the text discusses some applications in fracture mechanics. The book will be of great use to engineers who want to ...

This book presents the theoretical concepts of stress and strain, as well as the strengthening and fracture mechanisms of engineering materials in an accessible level for non-expert readers, but without losing scientific rigor. This volume fills the gap between the specialized books on mechanical behavior, physical metallurgy and material science and engineering books on strength of materials, structural design and materials failure. Therefore it is intended for college students and practicing engineers that are learning for the first time the mechanical behavior and failure of engineering materials or wish to deepen their understanding on these topics. The book includes specific topics seldom covered in other books, such as: how to determine a state of stress, the relation between stress definition and mechanical design, or the theory behind the methods included in industrial standards to assess

defects or to determine fatigue life. The emphasis is put into the link between scientific knowledge and practical applications, including solved problems of the main topics, such as stress and strain calculation. Mohr's Circle, yield criteria, fracture mechanics, fatigue and creep life prediction. The volume covers both the original findings in the field of mechanical behavior of engineering materials, and the most recent and widely accepted theories and techniques applied to this topic. At the beginning of some selected topics that by the author's judgement are transcendental for this field of study, the prime references are given, as well as a brief biographical semblance of those who were the pioneers or original contributors. Finally, the intention of this book is to be a textbook for undergraduate and graduate courses on Mechanical Behavior, Mechanical Metallurgy and Materials Science, as well as a consulting and/or training material for practicing engineers in industry that deal with mechanical design, materials selection, material processing, structural integrity assessment, and for researchers that incursion for the first time in the topics covered in this book.

Mechanics in Material Space

Fracture Mechanics

Problems of Fracture Mechanics and Fatigue

Fracture Mechanics of Electromagnetic Materials

- self-contained and well illustrated - complete and comprehensive derivation of mechanical/mathematical results with emphasis on issues of practical importance

- combines classical subjects of fracture mechanics with modern topics such as microheterogeneous materials, piezoelectric materials, thin films, damage - mechanically and mathematically clear and complete derivations of results

Created in 1975, LMT-Cachan is a joint laboratory École Normale Supérieure de Cachan, Pierre & Marie Curie (Paris 6) University and the French Research Council CNRS (Department of Engineering Sciences). The Year 2000 marked the 25th anniversary of LMT. On this occasion, a series of lectures was organized in Cachan in September-October, 2000. This publication contains peer-reviewed proceedings of these lectures and is aimed to present engineers and scientists with an overview of the latest developments in the field of damage mechanics. The formulation of damage models and their identification procedures were discussed for a variety of materials.

The aim of the book is to present, in a novel and unified fashion, the elements of Mechanics in Material Space or Configurational Mechanics, with applications to fracture and defect mechanics. This mechanics, in contrast to Newtonian mechanics in physical space, is concerned with defects such as cracks and dislocations, which are embedded in the material and might move in it. The level is kept accessible to any engineer, scientist or graduate student possessing some knowledge of calculus and partial differential equations, and working in the various areas where rational use of materials is essential.

Since the first edition published in 1991, this has been one of the top-selling books in the field. The first and second editions have been used as a required text in over 100 universities worldwide and have become

indispensable reference for thousands of practising engineers as well. The third edition reflects recent advances in the field, although

Fundamentals and Applications

Application of Fracture Mechanics to Composite Materials

Fundamentals of Fracture Mechanics

Models and Phenomena in Fracture Mechanics

Fracture mechanics is a vast and growing field. This book develops the basic elements needed for both fracture research and engineering practice. The emphasis is on continuum mechanics models for energy flows and crack-tip stress- and deformation fields in elastic and elastic-plastic materials. In addition to a brief discussion of computational fracture methods, the text includes practical sections on fracture criteria, fracture toughness testing, and methods for measuring stress intensity factors and energy release rates. Class-tested at Cornell, this book is designed for students, researchers and practitioners interested in understanding and contributing to a diverse and vital field of knowledge.

FRACTURE MECHANICS OF CONCRETE AND ROCK

This book offers engineers a unique opportunity to learn, from internationally recognized leaders in their field, about the latest theoretical advances in fracture mechanics in concrete, reinforced concrete structures, and rock. At the same time, it functions as a superb, graduate-level introduction to fracture mechanics concepts and analytical techniques. Reviews, in depth, the basic theory behind fracture mechanics \* Covers the application of fracture mechanics to compression failure, creep, fatigue, torsion, and other advanced topics \* Extremely well researched, applies experimental evidence of damage to a wide range of design cases \* Supplies all relevant formulas for stress

intensity \* Covers state-of-the-art linear elastic fracture mechanics (LEFM) techniques for analyzing deformations and cracking \* Describes nonlinear fracture mechanics (NLFM) and the latest RILEM modeling techniques for testing nonlinear quasi-brittle materials \* And much more Over the past few years, researchers employing techniques borrowed from fracture mechanics have made many groundbreaking discoveries concerning the causes and effects of cracking, damage, and fractures of plain and reinforced concrete structures and rock. This, in turn, has resulted in the further development and refinement of fracture mechanics concepts and tools. Yet, despite the field's growth and the growing conviction that fracture mechanics is indispensable to an understanding of material and structural failure, there continues to be a surprising shortage of textbooks and professional references on the subject. Written by two of the foremost names in the field, *Fracture Mechanics of Concrete* fills that gap. The most comprehensive book ever written on the subject, it consolidates the latest theoretical research from around the world in a single reference that can be used by students and professionals alike. *Fracture Mechanics of Concrete* is divided into two sections. In the first, the authors lay the necessary groundwork with an in-depth review of fundamental principles. In the second section, the authors vividly demonstrate how fracture mechanics has been successfully applied to failures occurring in a wide array of design cases. Key topics covered in these sections include: \* State-of-the-art linear elastic fracture mechanics (LEFM) techniques for analyzing deformations and cracking \* Nonlinear fracture mechanics (NLFM) and the latest RILEM modeling techniques for testing nonlinear quasi-brittle materials \* The use of R-Curves to describe cracking and fracture in quasi-

brittle materials \* The application of fracture mechanics to compression failure, creep, fatigue, torsion, and other advanced topics The most timely, comprehensive, and authoritative book on the subject currently available, *Fracture Mechanics of Concrete* is both a complete instructional tool for academics and students in structural and geotechnical engineering courses, and an indispensable working resource for practicing engineers. Almost all books available on fracture mechanics cover the majority of topics presented in this book, and often much, much more. While great as references, this makes teaching from them more difficult because the materials are not typically presented in the order that most professors cover them in their lectures and more than half the information p

These volumes constitute the Proceedings of a Symposium on the Fracture Mechanics of Ceramics, held at the Pennsylvania State University, University Park, Pennsylvania, July 11, 12, and 13, 1973. The theme of the symposium focused on the mechanical behavior of brittle ceramics in terms of the characteristics of cracks. The 52 contributed papers by 87 authors, present an overview of the current understanding of the theory and application of fracture mechanics to brittle ceramics. The program chairmen gratefully acknowledge the financial assistance for the Symposium provided by the Office of Naval Research, the College of Earth and Mineral Sciences of the Pennsylvania State University, the Materials Research Center of Lehigh University, Bethlehem, Pennsylvania and Westinghouse Research Laboratories, Pittsburgh, Pennsylvania. Special appreciation is extended to the expert organization provided by the J. Orvis Keller Conference Center of the Pennsylvania State University. In particular, Mrs. Patricia Ewing should be acknowledged for the excellent

program organization and planning. Dean Harold J. O'Brien, who was featured as the after-dinner speaker and who presented a most stimulating talk on the communication between people, also contributed to the success of the meeting. Finally, we also wish to thank our joint secretaries for the patience and help in bringing these Proceedings to press. University Park R. C. Bradt Bethlehem D. P. H. Hasseiman Pittsburgh, Pennsylvania F. F. Lange July, 1973 v CONTENTS OF VOLUME 2 Contents of Volume 1 . . . . .

Volume 2 Microstructure, Materials, and Applications  
With Applications to Defect and Fracture Mechanics  
Theory - Numerics - Applications  
A General Introduction to Fracture Mechanics

The complexity surrounding the subjects of fracture mechanics and fatigue and the difficulties experienced by academics, researchers and engineers in comprehending the use of different approaches/solutions necessitated the writing of this book. The book, written by a selection of 15 world experts provides a step by step solution guide for a 139 problems. In its unique form, the book can provide valuable information for a selection of problems which cover the most important aspects of both fracture mechanics and fatigue. The use of references, theoretical background and accurate explanations allow the book to work on its own or as complementary material to other related titles.

This edition comprehensively updates the field of fracture mechanics by including details of the latest research programmes. It contains new material on non-metals, design issues and statistical aspects. The application of fracture mechanics to different types of materials is stressed.

Fracture mechanics has established itself as an important discipline of growing interest to those working to assess the safety, reliability and service life of engineering structures and materials. In order to

calculate the loading situation at cracks and defects, nowadays numerical techniques like finite element method (FEM) have become indispensable tools for a broad range of applications. The present monograph provides an introduction to the essential concepts of fracture mechanics, its main goal being to procure the special techniques for FEM analysis of crack problems, which have to date only been mastered by experts. All kinds of static, dynamic and fatigue fracture problems are treated in two- and three-dimensional elastic and plastic structural components. The usage of the various solution techniques is demonstrated by means of sample problems selected from practical engineering case studies. The primary target group includes graduate students, researchers in academia and engineers in practice.

Introduction to Fracture Mechanics presents an introduction to the origins, formulation and application of fracture mechanics for the design, safe operation and life prediction in structural materials and components. The book introduces and informs the reader on how fracture mechanics works and how it is so different from other forms of analysis that are used to characterize mechanical properties. Chapters cover foundational topics and the use of linear-elastic fracture mechanics, involving both  $K$ -based characterizing parameter and  $G$ -based energy approaches, and how to characterize the fracture toughness of materials under plane-strain and non plane-strain conditions using the notion of crack-resistance or  $R$ -curves. Other sections cover far more complex nonlinear-elastic fracture mechanics based on the use of the  $J$ -integral and the crack-tip opening displacement. These topics largely involve continuum mechanics descriptions of crack initiation, slow crack growth, eventual instability by overload fracture, and subcritical cracking. Presents how, for a given material, a fracture toughness value can be measured on a small laboratory sample and then used directly to predict the failure (by fracture, fatigue, creep, etc.) of a much larger structure in service Covers the rudiments of fracture mechanics from the perspective of the philosophy underlying the few

principles and the many assumptions that form the basis of the discipline Provides readers with a "working knowledge" of fracture mechanics, describing its potency for damage-tolerant design, for preventing failures through appropriate life-prediction strategies, and for quantitative failure analysis (fracture diagnostics)

### Case Studies

Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials

Fracture Mechanics of Rock

Including an Introduction to Fatigue

A Practical Approach to Fracture Mechanics provides a concise overview on the fundamental concepts of fracture mechanics, discussing linear elastic fracture mechanics, fracture toughness, ductile fracture, slow crack propagation, structural integrity, and more. The book outlines analytical and experimental methods for determining the fracture resistance of mechanical and structural components, also demonstrating the use of fracture mechanics in failure analysis, reinforcement of cracked structures, and remaining life estimation. The characteristics of crack propagation induced by fatigue, stress-corrosion, creep, and absorbed hydrogen are also discussed. The book concludes with a chapter on the structural integrity analysis of cracked components alongside a real integrity assessment. This book will be especially useful for students in mechanical, civil, industrial, metallurgical, aeronautical and chemical engineering, and for professional engineers looking for a refresher on core principles. Concisely outlines the underlying fundamentals of fracture mechanics, making physical concepts clear and simple and providing easily-understood applied examples Includes solved problems of the most common calculations, along with step-by-step procedures to perform widely-used methods in fracture mechanics

Demonstrates how to determine stress intensity factors and fracture toughness, estimate crack growth rate, calculate failure load, and other methods and techniques

This multiauthor volume provides a useful summary of current knowledge on the application of fracture mechanics to composite materials. It has been written to fill the gap between the literature on fundamental principles of fracture mechanics and the special publications on the fracture properties of conventional materials, such as metals, polymers and ceramics. The data are represented in the form of about 420 figures (including diagrams, schematics and photographs) and 80 tables. The author index covers more than 500 references, and the subject index more than 1000 key words.

This book discusses the basic principles and traditional applications of fracture mechanics, as well as the cutting-edge research in the field over the last three decades in current topics like composites, thin films, nanoindentation, and cementitious materials. Experimental methods play a major role in the study of fracture mechanics problems and are used for the determination of the major fracture mechanics quantities such as stress intensity factors, crack tip opening displacements, strain energy release rates, crack paths, crack velocities in static and dynamic problems. These methods include electrical resistance strain gauges, photoelasticity, interferometry techniques, geometric and interferometry moiré, and the optical method of caustics. Furthermore, numerical methods are often used for the determination of fracture mechanics parameters. They include finite and boundary element methods, Green's function and weight functions, boundary collocation, alternating methods, and integral transforms continuous dislocations. This third edition

of the book covers the basic principles and traditional applications, as well as the latest developments of fracture mechanics. Featuring two new chapters and 30 more example problems, it presents a comprehensive overview of fracture mechanics, and includes numerous examples and unsolved problems. This book is suitable for teaching fracture mechanics courses at the undergraduate and graduate levels. A "solutions manual" is available for course instructors upon request.

Since the beginning of the century the technological desire to master the fracture of metals, concrete or polymers has boosted research and has left behind an overwhelming amount of literature. In a field where it seems difficult to say anything simple and new, the editors and authors of this book have managed to do just that. The approach to fracture taken here was not conceived by mechanical engineers or material scientists. It is essentially the by-product of exciting developments that have occurred in the last ten to fifteen years within a branch of theoretical physics, called statistical physics. Concepts such as "percolation" and "fractals", as models for the properties of fracture are not often considered by engineers. A particular aim of this volume is to emphasize the fundamental role disorder plays in the breaking process. The main scope of the volume is pedagogical and is at the same time an overview of fracture mechanics for physicists and an introduction to new concepts of statistical physics for mechanics and engineers. To this end the first half of the book consists of introductory chapters and the second half contains the results that have emerged from this new approach.

With an Introduction to Micromechanics  
Fracture Mechanics of Ceramics

## An Introduction

Continuum Damage Mechanics of Materials and Structures  
Advances in Research on the Strength and Fracture of  
Materials: Volume 1s—An Overview contains the  
proceedings of the Fourth International Conference on  
Fracture held at the University of Waterloo, Canada, in  
June 1977. The papers review the state of the art with  
respect to fracture in a wide range of materials such as  
metals and alloys, polymers, ceramics, and composites.  
This volume is comprised of 40 chapters and opens with a  
discussion on progress in the development of elementary  
fracture mechanism maps and their application to metal  
deformation processes, along with micro-mechanisms of  
fracture and the fracture toughness of engineering alloys.  
The next section is devoted to the fracture of large-scale  
structures such as steel structures, aircraft, cargo  
containment systems, nuclear reactors, and pressure  
vessels. Fracture at high temperatures and in sensitive  
environments is then explored, paying particular attention  
to creep failure by cavitation under non-steady conditions;  
the effects of hydrogen and impurities on brittle fracture  
in steel; and mechanism of embrittlement and brittle  
fracture in liquid metal environments. The remaining  
chapters consider the fracture of non-metallic materials as  
well as developments and concepts in the application of  
fracture mechanics. This book will be of interest to  
metallurgists, materials scientists, and structural and  
mechanical engineers.

Fracture and Fracture Mechanics: Case Studies contains

the proceedings of the Second National Conference on Fracture, held at the University of the Witwatersrand in Johannesburg, South Africa on November 26-27, 1984. This book presents case studies in fracture and fracture mechanics and highlights the problems associated with fracture, failure analysis, and safe design in industries as diverse as mining, power generation, transport, petrochemical, and manufacturing. This book has 29 chapters divided into five sections and opens with a discussion on the role of professional complacency in bridge failures. The first section is devoted to failure investigation and covers topics ranging from failure analysis of a hydraulic retarder piston to the use of scanning electron microscopy in investigating tungsten carbide-cobalt fractured components. The second section deals with slow crack growth and considers an approach to assessing structural integrity and fatigue failures in vibrating equipment. Failures arising from repair welding and incomplete heat treatment are described. The remaining chapters explore fitness for purpose evaluation of fractures; the environmental effects of fractures; and case studies of failure prevention in industries such as petrochemical, power generation, and transportation. This monograph will be of interest to structural engineers, metallurgists, and materials scientists and technologists. Most design engineers are tasked to design against failure, and one of the biggest causes of product failure is failure of the material due to fatigue/fracture. From leading experts in fracture mechanics, this new text provides new

approaches and new applications to advance the understanding of crack initiation and propagation. With applications in composite materials, layered structures, and microelectronic packaging, among others, this timely coverage is an important resource for anyone studying or applying concepts of fracture mechanics. Concise and easily understood mathematical treatment of crack tip fields (chapter 3) provides the basis for applying fracture mechanics in solving practical problems. Unique coverage of bi-material interfacial cracks (chapter 8), with applications to commercially important areas of composite materials, layered structures, and microelectronic packaging. A full chapter (chapter 9) on the cohesive zone model approach, which has been extensively used in recent years to simulate crack propagation. A unified discussion of fracture criteria involving nonlinear/plastic deformations

**Fracture Mechanics of Electromagnetic Materials** provides a comprehensive overview of fracture mechanics of conservative and dissipative materials, as well as a general formulation of nonlinear field theory of fracture mechanics and a rigorous treatment of dynamic crack problems involving coupled magnetic, electric, thermal and mechanical field quantities. Thorough emphasis is placed on the physical interpretation of fundamental concepts, development of theoretical models and exploration of their applications to fracture characterization in the presence of magneto-electro-thermo-mechanical coupling and dissipative effects.

Mechanical, aeronautical, civil, biomedical, electrical and electronic engineers interested in application of the principles of fracture mechanics to design analysis and durability evaluation of smart structures and devices will find this book an invaluable resource.

Advanced Fracture Mechanics and Structural Integrity

Fracture and Fracture Mechanics

Fatigue of Structures and Materials

Statistical Models for the Fracture of Disordered Media

New developments in the applications of fracture mechanics to engineering problems have taken place in the last years. Composite materials have extensively been used in engineering problems. Quasi-brittle materials including concrete, cement pastes, rock, soil, etc. all benefit from these developments. Layered materials and especially thin film/substrate systems are becoming important in small volume systems used in micro and nanoelectromechanical systems (MEMS and NEMS).

Nanostructured materials are being introduced in our every day life. In all these problems fracture mechanics plays a major role for the prediction of failure and safe design of materials and structures. These new challenges motivated the author to proceed with the second edition of the book. The second edition of the book contains four new chapters in addition to the ten chapters of the first edition. The fourteen chapters of the book cover the basic principles and traditional applications, as well as the latest developments of fracture mechanics as applied to problems of composite materials, thin films,

nanindentation and cementitious materials. Thus the book provides an introductory coverage of the traditional and contemporary applications of fracture mechanics in problems of utmost technological importance. With the addition of the four new chapters the book presents a comprehensive treatment of fracture mechanics. It includes the basic principles and traditional applications as well as the new frontiers of research of fracture mechanics during the last three decades in topics of contemporary importance, like composites, thin films, nanindentation and cementitious materials. The book contains fifty example problems and more than two hundred unsolved problems. A "Solutions Manual" is available upon request for course instructors from the author.

Advanced Fracture Mechanics and Structural Integrity is organized to cover quantitative descriptions of crack growth and fracture phenomena. The mechanics of fracture are explained, emphasizing elastic-plastic and time-dependent fracture mechanics. Applications are presented, using examples from power generation, aerospace, marine, and chemical industries, with focus on predicting the remaining life of structural components and advanced testing methods for structural materials.

Numerous examples and end-of-chapter problems are provided, along with references to encourage further study. The book is written for use in an advanced graduate course on fracture mechanics or structural integrity.

Fracture Mechanics is a graduate level text/professional

reference that describes the analytical methods used to derive stress and strain functions related to fracture mechanics. The focus of the book will be on modeling and problem solving as tools to be used in interpreting the meaning of a mathematical solution for a particular engineering problem or situation. Once this is accomplished, the reader should be able to think mathematically, foresee metallurgically the significance of microstructural parameters on properties, analyze the mechanical behavior of materials, and recognize realistically how dangerous a crack is in a stressed structure, which may fail catastrophically. This book differs from others in that the subject matter is organized around the modeling and predicating approaches that are used to explain the detrimental effects of crack growth events. Thus, this book will take a more practical approach and make it especially useful as a basic reference for professional engineers.

This Third Edition of the well-received engineering materials book has been completely updated, and now contains over 1,100 citations. Thorough enough to serve as a text, and up-to-date enough to serve as a reference. There is a new chapter on strengthening mechanisms in metals, new sections on composites and on superlattice dislocations, expanded treatment of cast and powder-produced conventional alloys, plastics, quantitative fractography, JIC and KIEAC test procedures, fatigue, and failure analysis. Includes examples and case histories.

Analysis of Engineering Structures and Material Behavior

A Practical Approach to Fracture Mechanics  
Fracture Mechanics of Concrete  
Nonlinear Field Theory and Applications