

# Preface

I have taught for at least 40 years, the engineering mechanics under various aspects such as the continuum mechanics of deformable bodies, the plasticity, the viscoplasticity, the mechanic of damage and fracture, the magnetic and classical shape memory alloys and also the fluid mechanic.

The people interested by these courses has changed over the years from “the maitrise de technologie de construction” to “the maitrise de mécanique”, and also “the DEA de sciences des matériaux”.

Including the students of the “l’école nationale supérieure de mécanique et des microtechniques de Besançon (ENSMM Besançon)”.

Concerning the mechanic of solid materials, the book of J. Lemaitre and J.L. Chaboche (1985) became the reference. It also expanded with two supplementary authors named “A. Benallal et R. Desmorat”, to reach 577 pages in its third edition in 2009.

Following the drafting of about 500 pages of handouts, I decided to write a textbook, incorporating “in situ” exercises to facilitate a better understanding of the students.

My sources were mainly the following:

- J. Mandel. Introduction à la mécanique des milieux continus déformables. Académie Polonaise des Sciences, 1974.
- G. Cailletaud, M. Tijani, S. Cantournet, L. Corte, S. El Arene, S. Forest, E. Herve-Luanco, M. Mazier, H. Proudhon, and D. Ryckelink. Mécanique des Matériaux solides (Notes de cours). Mines-Paris-Tech, 2011.
- Q.S. Nguyen. Problèmes de plasticité et de rupture. Publications Mathématiques d’Orsay (Université de Paris-Sud), 1982. Cours de DEA
- P. Suquet. Rupture et Plasticité. Ecole Polytechnique, 2003. Cours de Master I.
- J.B. Leblond. Mécanique de la rupture fragile et ductile. (the two first chapters) Hermès- Lavoisier, 2003.

So if a teaching book should be a consistent and synthetic compilation, it addresses generally “known things” even if sometimes it overflows on research.

Thus, I wish to warmly thank my colleagues who have inspired me in writing this book.

Thank you to my colleagues of the ENSMM: Frédérique Trivaudey, Jacques Dufaud, Violaine Retel-Guicheret and Sylvaine Mallet who accompanied me in teaching the mechanics of deformable continuous media.

Finally, Joel Abadie drew quarantine figures.

Without him again and Scott Cogan, I would not have been able to extricate myself from meandering LYX (word processor used in the writing of this book).

English language was seriously amended by Benoit Vieille from INSA Rouen (France).

To address the linear and nonlinear behaviors of solid materials, the concepts of deformation, displacement, and stress will be introduced.

Most of the time, the developments herein will be restricted to small perturbations, with the exception of shape memory alloys, which may have substantial deformations, whose magnitude can reach 8% and shape memory polymers or materials with superplastic deformations, and whose deformations can reach several hundred percent.

Chapter 1 provides a brief overview of solid mechanics, experimental methods, and classes of material behaviors.

Chapter 2 lays the foundations for the thermodynamic modeling framework based on the aforementioned concepts of deformation, displacement, and stress.

Linear elastic behavior and thermoelasticity will be presented in Chap. 3 along with exercises in continuum mechanics.

Chapter 4 introduces the criteria to the elastic yield domain with special attention to the asymmetry in the tension and compression behaviors.

Chapter 5 deals with the plastic behaviors in the framework of generalized standard materials.

Chapter 6 presents viscoelasticity with a description of the advantages and drawbacks of conventional models such as Kelvin-Voigt, Maxwell, and Zener.

Chapter 7 is devoted to the study of viscoplasticity in a classical range. At the end of the chapter, a parallel is made between plastic and viscoplastic behaviors.

Chapters 8 and 9 are devoted to conventional and magnetic shape memory alloys, so-called “smart materials” which may be used as actuators or sensors in adaptive structures.

Finally, Chap. 10 examines fracture mechanics and damage behavior.

I leave the task of developing numerical models in structural mechanics to my colleagues.

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