UNIVERSITÀ DI PAVIA

Anno Accademico 2018/2019

CONSTITUTIVE MODELING OF MATERIALS	
Enrollment year	2018/2019
Academic year	2018/2019
Regulations	DM270
Academic discipline	ING-IND/34 (INDUSTRIAL BIOENGINEERING)
Department	DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING
Course	BIOENGINEERING
Curriculum	Bioingegneria delle cellule e dei tessuti
Year of study	1°
Period	1st semester (01/10/2018 - 18/01/2019)
ECTS	6
Lesson hours	60 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	AURICCHIO FERDINANDO - 4 ECTS CONTI MICHELE - 2 ECTS
Prerequisites	Basic knowledge of algebra, solid mechanics (introductory concepts of deformation and tension), numerical calculus.
Learning outcomes	The course wishes to introduce the attending student to analytical and numerical mathematical models for the description of material costitutive behavior. Starting from a general theory for deformable bodies, we will discuss elastic and inelastic relations (presenting visco-elastic, visco-plastic and plastic models, possibly with some comments on damage and fatigue), for isotropic and non-isotropic materials, giving also some hints on their numerical solutions. We will also discuss the extension of some specific models to the finite strain regime.

Course contents

The module aims at introducing the study and use of mathematical models for the analytical and numerical description of the onstitutive behavior of materials.
Starting with a general overview of the theory of deformable bodies, the course will address the development of elastic and inelastic (discussing models of visco-elasticity, visco-plasticity, plasticity, with possible extensions to the case of damage and fatigue) models, for isotropic and anisotropic materials, also giving hints for their solution to the problems in the field of numerical.
The course will also discuss the extension of some models under the large deformations.

- Algebra tensor
- Fundamentals of mechanics of deformable bodies in the case of large displacements. Analysis of the deformation. Equilibrium. Particularization to the case of small displacement gradients.
- Basic principles for the development of constitutive laws: invariance and symmetry observer material
- Elastic models in small deformations: Cuachy and Green. Development of models for different symmetries material: isotropic materials, materials with one or two famiglie of fibers. Extension to the case of large deformations.
- Development of a computer script (in matlab) for the simulation of tension/displacement-driven tests.
- Application to the case of particular classes of materials (e.g., polymers, composite materials, soft biological tissues, etc.). Comparison with experimental data and the development of a program for the automatic determination of the constitutive parameters.
- Models in small inelastic deformations: visco-elasticity, visco-plasticity, plasticity classical plasticity with isotropic and kinematic hardening.
- Integration schemes for the numerical solution and development of a computer script (in matlab) for the simulation of tension/displacement-driven tests.
- Application to the case of particular classes of inelastic materials (e.g., metals, concrete, etc.). Comparison with experimental data.

Teaching methods

Lectures (hours/year in lecture theatre): 90
Practical class (hours/year in lecture theatre): 0
Practicals / Workshops (hours/year in lecture theatre): 0

Reccomended or required readings

Notes prepared by the teacher

Extra material for further studies:

Besson, J. et al. (2010) Non-linear mechanics of materials. Springer
Bonet, J. and R. Wood (1997). Nonlinear Continuum Mechanics for finite element analysis. Cambridge University Press.
Hjelmstad, K. (1997). Fundamentals of Structural Mechanics. Prentice Hall.
Holzapfel, G. (2000). Nonlinear solid mechanics: a continuum approach for engineering. John Wiley & Sons.
Lemaitre, J. and J. Chaboche (1990). Mechanics of solid materials. Cambridge University Press.
Lubliner, J. (1990). Plasticity theory. Macmillan.
Simo, J. and T. Hughes (1998). Computational inelasticity. Springer-Verlag.
Zienkiewicz, O. and R. Taylor (1991). The finite element method (fourth ed.), Volume II. New York: McGraw Hill.

Assessment methods

Written and oral final exam, with discussion of the proposed homeworks suggested during the course and eventually of a either theoretical or numerical final project.

Further information

Useful links:
http://www-2.unipv.it/compmech/teaching_av.html
http://www-2.unipv.it/compmech/mate-lab.html

Sustainable development goals - Agenda 2030

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