UNIVERSITÀ DI PAVIA

Anno Accademico 2021/2022

CONSTITUTIVE MODELING OF MATERIALS	
Enrollment year	2021/2022
Academic year	2021/2022
Regulations	DM270
Academic discipline	ING-IND/34 (INDUSTRIAL BIOENGINEERING)
Department	DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING
Course	BIOENGINEERING
Curriculum	Cellule, tessuti e dispositivi
Year of study	1°
Period	1st semester (27/09/2021 - 21/01/2022)
ECTS	6
Lesson hours	57 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	AURICCHIO FERDINANDO (titolare) - 3 ECTS ALAIMO GIANLUCA - 1 ECTS CONTI MICHELE - 2 ECTS
Prerequisites	Basic knowledge of algebra, solid mechanics (concepts introduction of deformation and tension), of numerical calculation.
Learning outcomes	The module aims to introduce the student to the study and use of analytical and numerical mathematical models for the description of the constitutive behavior of materials. Starting from a general framework of the theory of bodies deformable, the development of elastic and inelastic models will be addressed (discussing visco-elasticity models, visco-plasticity, plasticity, with possible extensions to the case of damage and fatigue), for isotropic and non-isotropic materials,

	also giving hints to the problems for their solution in numerical area. The mechanical tests to be performed for the calibration of the models will also be discussed.
Course contents	The module aims to introduce the student to the study and use of analytical and numerical mathematical models for the description of the constitutive behavior of materials. Starting from a general framework of the theory of bodies deformable, the development of elastic and inelastic models will be addressed (discussing visco-elasticity models, visco-plasticity, plasticity, with possible extensions to the case of damage and fatigue), for isotropic and non isotropic materials, also giving hints to the problems for their solution in numerical area. Mechanical tests will be discussed. Review of tensor algebra Fundamentals of deformable bodies kinematics. Deformation analysis. Equilibrium. Specialization in the case of small displacement gradients. Fundamental principles for the development of constitutive models: invariance of the observer and material symmetry Elastic models in small deformations: Cauchy elasticity and Green elasticity. Development of models for different material symmetries: isotropic materials, materials with one family of fibers, materials with two families of fibers. Extension to the case of large deformations. Development of a calculation program (for example in matlab) for the simulation of strain and / or stress control stories. Application to the case of particular classes of materials (for example, polymers, composite materials, soft biological tissues, etc.). Comparison with experimental data and development of a determination program automatic constitutive parameters. Inelastic models in small deformations: visco-elasticity, visco-plasticity, classical plasticity, plasticity with isotropic hardening e kinematic. Integration schemes numerical solution and program development of calculation (for example, in matlab) for the simulation of stories to control of deformation and / or tension. Application to the case of particular classes of inelastic materials (for example, metallic materials, concrete, etc.). Comparison with data experimental. Basic knowledge of damage and fatigue of materials will be provided as well.
Teaching methods	Taught lesson; when required, the implementation of the proposed models will be performed using computer.
Reccomended or required	Notes prepared by the teacher

readings	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	$lbl_legenda_sviluppo_sostenibile