UNIVERSITÀ DI PAVIA

## Anno Accademico 2021/2022

| CONSTITUTIVE MODELING OF MATERIALS | |
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| Enrollment year | 2020/2021 |
| Academic year | 2021/2022 |
| Regulations | DM270 |
| Academic discipline | ICAR/08 (CONSTRUCTION SCIENCE) |
| Department | DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE |
| Course | CIVIL ENGINEERING |
| Curriculum | Strutturistico |
| Year of study | 2° |
| 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<br>ALAIMO GIANLUCA - 1 ECTS<br>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.<br>Starting from a general framework of the theory of bodies deformable, the development of elastic and inelastic models will be addressed<br>(discussing visco-elasticity models, visco-plasticity, plasticity, with possible extensions to the case of damage and fatigue), for isotropic and non-isotropic materials,<br>also giving hints to the problems for their solution in |

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| | numerical area.<br>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.<br>Starting from a general framework of the theory of bodies<br>deformable, the development of elastic and inelastic models will be addressed<br>(discussing visco-elasticity models, visco-plasticity, plasticity, with possible extensions to the case of damage and fatigue), for isotropic and non isotropic materials,<br>also giving hints to the problems for their solution in<br>numerical area.<br>Mechanical tests will be discussed.<br>Review of tensor algebra<br>Fundamentals of deformable bodies kinematics. Deformation analysis.<br>Equilibrium. Specialization in the case of small displacement gradients.<br>Fundamental principles for the development of constitutive models: invariance<br>of the observer and material symmetry<br>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.<br>Extension to the case of large deformations.<br>Development of a calculation program (for example in matlab) for the simulation of strain and / or stress control stories.<br>Application to the case of particular classes of materials (for example, polymers, composite materials, soft biological tissues, etc.).<br>Comparison with<br>experimental data and development of a determination program<br>automatic constitutive parameters.<br>Inelastic models in small deformations: visco-elasticity, visco-plasticity, classical plasticity, plasticity with isotropic hardening e<br>kinematic.<br>Integration schemes numerical solution and program development<br>of calculation (for example, in matlab) for the simulation of stories to control of<br>deformation and / or tension.<br>Application to the case of particular classes of inelastic materials (for example, metallic materials, concrete, etc.). Comparison with data experimental.<br>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 readings** | Notes prepared by the teacher<br>Extra material for further studies: |

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| | Besson, J. et al. (2010) Non-linear mechanics of materials. Springer<br>Bonet, J. and R. Wood (1997). Nonlinear Continuum Mechanics for finite<br>element analysis. Cambridge University Press.<br>Hjelmstad, K. (1997). Fundamentals of Structural Mechanics. Prentice Hall.<br>Holzapfel, G. (2000). Nonlinear solid mechanics: a continuum approach for engineering. John Wiley & Sons.<br>Lemaitre, J. and J. Chaboche (1990). Mechanics of solid materials. Cambridge University Press.<br>Lubliner, J. (1990). Plasticity theory. Macmillan.<br>Simo, J. and T. Hughes (1998). Computational inelasticity. Springer-Verlag.<br>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:<br>http://www-2.unipv.it/compmech/teaching_av.html<br>http://www-2.unipv.it/compmech/mate-lab.html |
| **Sustainable development goals - Agenda 2030** | $lbl_legenda_sviluppo_sostenibile |