UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

ADVANCED SOLID AND STRUCTURAL MECHANICS

Anno immatricolazione	2019/2020
Anno offerta	2020/2021
Normativa	DM270
SSD	ICAR/08 (SCIENZA DELLE COSTRUZIONI)
Dipartimento	DIPARTIMENTO DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE
Corso di studio	BIOINGEGNERIA
Curriculum	Cellule, tessuti e dispositivi
Anno di corso	2°
Periodo didattico	Primo Semestre (28/09/2020 - 22/01/2021)
Crediti	6
Ore	45 ore di attività frontale
Lingua insegnamento	INGLESE
Tipo esame	SCRITTO E ORALE CONGIUNTI
Docente	AURICCHIO FERDINANDO (titolare) - 4 CFU SCALET GIULIA - 2 CFU
Prerequisiti	Knowledge of the concepts given within the courses of Rational Mechanics and Structural Mechanics.
Obiettivi formativi	The course aims to advance the knowledge and understanding of the mathematical and physical foundations of continuum mechanics of solids and to enhance the ability to apply its principles to solve structural engineering problems.
Programma e contenuti	• An introduction o Mechanics of deformable solids: definition o Model construction vs physical reality o Mechanical modeling basic ingredients: kinematics, equilibrium, constitutive equations

• Review on vector and tensors
o Vectors and tensors: an introduction
o Compact, indicial, engineering/Voigt notations
o Operations between vectors and tensors
o Vector and tensor calculus

• Review of solid mechanics (and notation) from basic courses (I)
o Kinematics
? change of configuration, reference & current configuration; reference configuration as a natural one for kinematics
? displacement field, gradient of change of configuration, Cauchy-Green deformation tensor, Green-Lagrange strain tensor
? Fundamental assumptions: small displacement gradient; interpretation of displacement fields in terms of rigid body and strain quotas
o Equilibrium
? current configuration as a natural one to study equilibrium
? external & internal actions, equilibrium for a deformable body in a integral format
? Principle of action/reaction, Cauchy stress tensor
o Principle of virtual work

• Review of solid mechanics (and notation) from basic courses (II)
o Material response and constitutive relations
o Green elasticity
o Isotropy

• Variational & energy-based formulations for 3D problems
o Minimum of free energy
o Minimum of complementary free energy
o Hellinger-Reissner and Hu-Washizu principles

• Plane beam model (1D structural model)
o Kinematic assumptions and beam-like strains
o Equilibrium from principle of virtual work and beam resultants
o Beam constitutive equations
o Euler-Bernoulli beam model
o Timoshenko beam model

• Plate model (2D structural model)
o Kinematic assumptions and plate-like strains
o Equilibrium from principle of virtual work and plate resultants
o Plate constitutive equations
o Kirchhoff-Love plate model
o Reissner-Mindlin plate model

• Principle of virtual work for (planar) beam
o PVW of planar beam problems
o Use of PVW to solve simple beam problems
o Use of PVW to solve over-constrained beam problems

• Energy-based formulations for 1D and 2D problems
o Derivation of Timoshenko plane beam model
o Derivation of Reissner-Mindlin plate model

	o Elasticity vs inelastic material response in terms of energy and dissipation • Limit analysis basic concepts and applications to beam problems o Simple truss structures: limit analysis o Kinematic theorems o Equilibrium theorems o Simple beam structures: limit analysis • Solid mechanics: finite strain extension o Kinematics ? Strain measure in the current configuration ? Push-forward and pull-back concept o Equilibrium ? First and second Piola-Kirchhoff stress tensor • Simple 1D structural theories: finite strain extension • Basic concepts of instability of structures
Metodi didattici	Blackboard lectures, slide lectures, Mathematica-based hands-on tutorials. The course will be held in English if the percentage of non-native Italian students is greater than 25%.
Testi di riferimento	- Lecture notes; - K.D. Hjelmstad, Fundamentals of Structural Mechanics, Second Edition, Springer; - L. Corradi dell'Acqua, La meccanica delle strutture, vol. 3, McGraw Hill (in particular, chap. 13 for limit analysis); - O. Zienkiewicz, R.L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Butterworth-Heinemann, 2013.
Modalità verifica apprendimento	The exam consists in a written evaluation, an oral discussion, and the assignment of Mathematica-based homework.
Altre informazioni	
Obiettivi Agenda 2030 per lo sviluppo sostenibile	$lbl_legenda_sviluppo_sostenibile