Università degli Studi di L'Aquila - Dipartimento di Ingegneria e Scienze dell'Informazione e Matematica

Course catalogue

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Programme of Course "An introduction to continuum mechanics"

- Code: DT0098
- Type of course unit: Elective (Master Degree in Mathematical Engineering curriculum Comune)
- Level of course unit: Postgraduate Degrees
- Semester: 2

Number of ects credits: (Master Degree in Mathematical Engineering) 12 (workload 300 hours)

Teachers: Amabile Tatone

1	**Course objectives**	To get familiar with kinematics of continuum, a suitable notion of force distribution, a general method delivering balance equations in continuum mechanics, the formal way of describing material properties and energy balance mainly for solid matter.
2	**Course content and learning outcomes (dublin descriptors)**	Topics of the module include: • Vector spaces; affine and Euclidean spaces; tensors; matrix of a tensor; symmetric and antisymmetric tensors; inverse of a tensor; tensor product; orthonormal basis; eigenvectors and eigenvalues; symmetric tensors; positive de?niteness of a tensor; antisymmetric tensors; orthogonal tensors; polar decomposition theorem; left and right stretch tensors; principal stretches; the Cayley–Hamilton theorem; Gauss and Stokes's theorems; applications of divergence theorem. • Placements and motions. Rigid and affine motions. Deformation gradient, stretch and rotation. Stretching and spin. Test velocity fields and force distributions. Working and stress. Working balance principle. Balance equations. Frame indifference principle. Affine bodies. Cauchy continuum. Cauchy stress and Piola-Kirchhoff stress. Material response. Material objectivity. Symmetry group and isotropy. Elastic and hyperelastic materials. Strain energy function. Constraints and reactive stress. Incompressibility. Mooney-Rivlin and neo-Hookean materials. Dissipative stress and dissipation principle. Fluids and solids. A general scheme for describing growth and relaxation via Kroner-Lee decomposition. Remodeling forces and stress. Eshelby tensor. Viscoelasticity. Numerical simulations with Comsol Multiphysics. On successful completion of this module, the student should : • have knowledge of the geometrical setting of continuum mechanics as well as related topics in linear algebra and basic notions on tensor analysis. • be able to read and understand the introductory chapters or appendices on tensor analysis in any book about continuum mechanics. • have knowledge of the basics in non linear continuum mechanics and viscoelasticity. • be able to formally describe basic and simple problems in mechanics of solids and soft matter and make use of state-of-the-art materials modelling. • be able to understand both results and procedures described in a technical report or scientific paper and to take part in a discussion on the subject with colleagues. • master the language and the use of the standard symbols and expressions which are used worldwide both in mathematics and mechanics. • be able to browse quickly or read carefully both technical and scientific papers or to attend conferences and seminars to increase his knowledge by choosing topics he may be interested in.
3	**Course prerequisites**	Basics on Calculus and Geometry. Some knowledge of linear algebra and basic notions in elementary mechanics of a pointwise body could be helpful.
4	**Teaching methodsand language**	Usually every topic is described mainly by a detailed, even lengthy, writing on the blackboard, together with explicit motivations, both theoretically and physically based. Simple numerical computations are often used, as well as numerical computer simulations. **Language**: English **Reference textbooks** • C. Truesdell, ***A First Course in Rational Continuum Mechanics***. Academic Press. 1977.

		• M. Gurtin, ***An Introduction to Continuum Mechanics***. Academic Press. 1981. • P. Chadwick, ***Continuum Mechanics: Concise Theory and Problems***. Dover Books on Physics. 1976.
5	**Assessment methods**	A few homework assignments and a final oral presentation and discussion about a subject related to the course topics.