UNIVERSITÀ DEGLI STUDI DI TRENTO
Dipartimento di Ingegneria Civile, Ambientale e Meccanica

Online PhD Course

Generalized continua as a means to model metamaterials

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April 8, 2024 (Monday)	15:00-18:00
April 9, 2024 (Tuesday)	15:00-18:00
April 10, 2024 (Wednesday)	10:00-12:00

Zoom link

Mechanical metamaterials, a captivating and innovative category of materials, have garnered significant attention due to their extraordinary mechanical properties. Engineered with intricate geometric arrangements and microstructures, these materials exhibit exceptional traits such as extreme stiffness, lightweightness, negative Poisson's ratio, chirality, dispersion, band gaps, negative group velocity, Bragg-scattering, local resonance, and even apparent negative mass density. Exploring their characteristics from static and dynamic perspectives reveals their versatility.

In particular, the study of the static of metamaterials finds applications in different fields. Key static features include a negative Poisson's ratio, enabling simultaneous expansion in both directions, extreme stiffness with a high stiffness-to-weight ratio, and tuneable properties adaptable to specific aims through microstructure parameter adjustments.

On the other hand, the study of dynamic metamaterials has the aim to tailor the mechanical properties of metamaterials in order to obtain unconventional properties in dynamical regimes. Notable dynamic features include vibration control for applications like noise reduction, wave propagation control for designing advanced acoustic devices, tailored dynamic responses for energy absorption or impact protection, and exceptional shock absorption capabilities.

Mechanical metamaterials leverage innovative microstructures to achieve exceptional static and dynamic properties, finding applications in aerospace, materials science, civil engineering, and robotics. Their unique characteristics continue to inspire research, offering the potential to revolutionise various industries.

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Programme:

1. Introduction to generalized models: models in the literature; variational principles to obtain equilibrium equations and boundary conditions (Cauchy and Micromorphic); a particular kind of boundary condition for micromorphic models.
2. Analytical solutions for a model that belongs to the micromorphic family, the Relaxed Micromorphic Model (RMM) in statics: simple shear tests, uniaxial extension tests, cylindrical bending tests, and torsion of a cylindrical rod tests.
3. Introduction to the dynamics of metamaterials: how to obtain the dispersion relation and characterise their properties.
4. How to calculate dispersion curves for a unit cell through Bloch-Floquet and examples of simulations in dynamics.

Gianluca Rizzi has been a postdoctoral researcher at the Chair of Continuum Mechanics, Technical University of Dortmund, since 2021. Before joining Dortmund, he worked as a postdoctoral researcher at the GEOMAS laboratory, INSA Lyon from 2019 to 2021. He completed his Ph.D. at the University of Trento from 2015 to 2019. His research interests revolve around modelling metamaterials using generalized continua both in statics and dynamics.