RE-FRACTURE2 ITN EID PROJECT

Summer School 2022

TC1: Nonlinear solid mechanics
TC2: Extreme mechanics

July 25 – 30, 2022

Department of Civil, Environmental
and Mechanical Engineering
via Mesiano, 77 - Trento

https://www.refracture2-h2020.eu/summerschool2022.php

Registration requests should be sent to: andrea.piccolroaz@unitn.it

Organised by:

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CAEmate Engineering, Made Easy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 955944 – RE-FRACTURE2.

RE-FRACTURE2 Summer School 2022

Time	Monday 25	Tuesday 26	Wednesday 27
9:00 – 10:30	Introduction to linear and nonlinear solid mechanics	Thermoelasticity and thermal stresses	Introduction to plasticity
10:30 – 11:00	Coffee break		
11:00 – 12:30	Introduction to linear and nonlinear solid mechanics	Thermoelasticity and thermal stresses	Introduction to plasticity
12:30 – 14:00	Lunch break		
14:00 – 15:30	Introduction to linear and nonlinear solid mechanics	Material instabilities	Introduction to plasticity
15:30 – 16:00	Coffee break		
16:30 – 17:30	Introduction to linear and nonlinear solid mechanics	Material instabilities	Introduction to plasticity
Time	**Thursday 28**	**Friday 29**	**Saturday 30**
9:00 – 10:30	Elastoplasticity at large strains	Viscoplasticity	Experimental mechanics
10:30 – 11:00	Coffee break		
11:00 – 12:30	Elastoplasticity at large strains	Viscoplasticity	Experimental mechanics
12:30 – 14:00	Lunch break		
14:00 – 15:30	Thermoplasticity and coupling effects	Material instabilities	
15:30 – 16:00	Coffee break		
16:30 – 17:30	Thermoplasticity and coupling effects	Material instabilities	

Introduction to linear and nonlinear solid mechanics

Francesco Dal Corso

An overview will be given on the main aspects of linear and nonlinear solid mechanics, with particular reference to:

- Linear theory of elasticity
- Kinematics and statics within a large deformation regime and different measures of strain and stress
- Constitutive equations in nonlinear mechanics: hyperelasticity
- Solution of simple Boundary Value Problems in finite elasticity

Reference:

- D. Bigoni (2012). Nonlinear Solid Mechanics: Bifurcation Theory and Material Instability. Cambridge University Press.

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Thermoelasticity and thermal stresses

Andrea Piccolroaz

The lecture aims to give an introduction to the theory of thermoelasticity and thermal stresses. The following topics will be covered:

- Thermodynamical foundations
- Heat conduction in solids
- Coupled and uncoupled thermoelasticity
- Thermal stress analysis

Reference:

- B. A. Boley, J. H. Weiner (2011). Theory of Thermal Stresses. Dover Publications-

Introduction to plasticity

Francesco Dal Corso

An introduction to the plastic response of solids at small strain will be given, with particular reference to:

- Experimental observations
- Haigh-Westergaard space and yield functions
- Incremental elasto-plastic constitutive equations for one- and three-dimensional states
- J2-flow theory of plasticity

Reference:

- J. C. Simo, T. J. R. Hughes (1998). Computational Inelasticity. Springer.
- D. Bigoni (2012). Nonlinear Solid Mechanics: Bifurcation Theory and Material Instability. Cambridge University Press.
- L. M. Kachanov (2004). Fundamentals of the Theory of Plasticity. Dover

Elastoplasticity at large strains

Andrea Piccolroaz

In this lecture the theory of plasticity will be extended to the large strain framework. Covered topics are:

- General hyperelastic-based multiplicative plasticity model
- J2 plasticity at finite strain
- A constitutive model for powder compaction: small strain and large strain formulations.

Reference:

- D. Bigoni (2012). Nonlinear Solid Mechanics: Bifurcation Theory and Material Instability. Cambridge University Press.
- Stupkiewicz, S., Piccolroaz, A., Bigoni, D. (2015). Finite-strain formulation and FE implementation of a constitutive model for powder compaction. Computer Methods in Applied Mechanics and Engineering, 283, 856-880.

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Thermoplasticity and coupling effects
Andrea Piccolroaz
The lecture will cover the theory of thermoplasticity, including:
- Thermodynamical framework
- Thermomechanical couplings
- Coupled thermomechanical problem
- Thermal softening
Reference:
- Negahban, M. (2012) The mechanical and thermodynamical theory of plasticity. CRC Press.

Viscoplasticity
Andrea Piccolroaz
The lecture will cover the theory of viscoplasticity, including:
- Phenomenological aspects and one-dimensional mathematical model of viscoplasticity
- General multidimensional model of viscoplasticity
Reference:
- EA de Souza Neto, D Peric, DRJ Owen (2008) Computational methods for plasticity. Theory and applications. Wiley Publication.

Material instabilities
Davide Bigoni
Solid mechanics in the incremental form, with a view on kinematics and statics. The essential structure of incremental constitutive theories. Global instabilities and bifurcations. Material instabilities. Positive definiteness of the constitutive operator, strong ellipticity, ellipticity and flutter instability.
Reference:
- D. Bigoni (2012). Nonlinear Solid Mechanics: Bifurcation Theory and Material Instability. Cambridge University Press.

Experimental mechanics
Diego Misseroni
The lecture aims to provide some insights into the experimental mechanics of solids and structures. First, an introduction to the experimental technologies and testing protocols adopted to determine the mechanical properties of materials will be given. Then, a laboratory tour will be proposed, and some real experiments will be carried out.
In particular, the following topic will be covered:
- Introduction to experimental mechanics;
- Tension and compression tests, three and four-point bending tests;
- Photoelasticity experimental principles;
- Lab tour, live experiments, data analysis and postprocessing.

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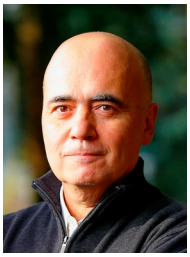
Francesco Dal Corso: After earning a PhD in Materials and Structural Engineering at the University of Trento, Italy, Francesco Dal Corso won a postdoctoral fellowship at the Department of Applied Mathematics and Theoretical Physics, University of Cambridge. He is currently an Associate Professor of Solid and Structural Mechanics at the University of Trento. His research activity is devoted to the Mechanical behaviour of Solid and Structures. He has co-authored over 40 journal papers and has co-guest edited a Special Issue of the Journal of the Mechanics and Physics of Solids in 2020.

Andrea Piccolroaz, Associate Professor of Solids and Structural Mechanics, received a PhD in Materials and Structural Engineering at the University of Trento (2004) and was a postdoc researcher at the Department of Mathematical Sciences, University of Liverpool (2006). In 2010 he won a Marie Curie grant for a two-year project at the Department of Mathematics, Aberystwyth University. He is/was the coordinator of two large Marie Curie ITN projects on numerical modelling of ceramics and refractory materials. His research interests include fracture mechanics, computational mechanics, constitutive modelling, plasticity, material instabilities, and microstructured materials.



Davide Bigoni is a Professor of Solid and Structural Mechanics at the University of Trento, where he has been head of the Department of Mechanical and Structural Engineering. He was honored as a Euromech Fellow of the European Mechanics Society. He is co-editor of the Journal of Mechanics of Materials and Structures and is associate editor of Mechanics Research Communications. He has been awarded the Panetti-Ferrari award and two ERC Advanced grants.

Diego Misseroni is an Associate Professor of Solid and Structural Mechanics at the University of Trento, Italy. He earned his Ph.D. in 'Engineering of Civil and Mechanical Structural Systems' from the University of Trento in 2013. In 2014, he was Marie Curie experienced researcher at the Department of Mathematical Sciences, University of Liverpool, UK. His research interests are in the field of the Mechanics of Solids and Structures and include wave propagation, metamaterials, origami engineering, buckling and instabilities of structures undergoing large deformations.

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