RE-FRACTURE2/BEYOND Summer School 2023 – Room L1 - H1

Summer School 2023

TC3: Advanced Computational Mechanics and implementation techniques

TC4: Constitutive modeling of advanced materials: numerical implementation and calibration through inverse analysis

CS1: Exploitation of Intellectual Property Rights

July 10 – 21, 2023

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

(Room L1 - H1)

https://www.refracture2-h2020.eu/summerschool2023.php

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

Organised by:

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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 and from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme, Grant agreement No. ERC-ADG-2021-101052956-BEYOND.

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Week 1

TC4: Constitutive modeling of advanced materials: numerical implementation and calibration through inverse analysis

Time	Monday 10 (room L1)	Tuesday 11 (room L1)	Wednesday 12 (room L1)
9:00 – 10:30	TC4: Concept of CM* as mathematical framework to describe material behavior	C4: Numerical implementation: inelastic models	TC4: Soft computing: genetic algorithms
10:30 – 11:00	Coffee break		
11:00 – 12:30	TC4: Formulation of CM for elastic and inelastic regime; internal variables and phenomenological models	TC4: Numerical implementation: large deformation and geometrically nonlinear problems	TC4: Inverse analysis: sensitivity analysis and setting up the problem
12:30 – 14:00	Lunch break		
14:00 – 15:30	TC4: Plasticity CM: formulation	TC4: Characterization of CM for elastic and inelastic regime: formulation through inverse analysis	TC4: Inverse analysis: practical hand-on example
15:30 – 16:00	Coffee break		
16:30 – 17:30	TC4: Numerical implementation of CM: general concept	TC4: Mathematical programming: iterative optimization algorithms	TC4: Time for open discussion and practical questions from participants

Time	Thursday 13	Friday 14	Saturday 15
9:00 – 10:30	1-on-1 meetings	1-on-1 meetings	
11:00 – 12:30			
14:00 – 15:30	1-on-1 meetings	1-on-1 meetings	
16:30 – 17:30			

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Week 2
TC3: Advanced Computational Mechanics and implementation techniques
CS1: Exploitation of Intellectual Property Rights

Time	Monday 17 (room H1)	Tuesday 18 (room H1)	Wednesday 19 (room H1)
9:00 – 10:30	Introduction to IP	Introduction to patents	TC3: Programming languages, an overview
10:30 – 11:00			
11:00 – 12:30	Introduction to IP	Patentability requirements	TC3: Practical examples, code implementation
12:30 – 14:00			
14:00 – 15:30	Trademarks	Practical exercise	TC3: Good practice in code development: why getting the code to work is not sufficient?
15:30 – 16:00			
16:30 – 17:30	Practical exercise	Q&A	TC3: Practical examples, code implementation, tests
Time	**Thursday 20 (room H1)**	**Friday 21 (room H1)**	**Saturday 22**
9:00 – 10:30	TC3: Introduction to Elastoplasticity	TC3: Inverse analysis, overview	
10:30 – 11:00			
11:00 – 12:30	TC3: Thermoplasticity and viscoplasticity	TC3: What is a UMAT and how to code it, examples	
12:30 – 14:00			
14:00 – 15:30	TC3: Integration algorithms for plasticity	TC3: UMAT implementation and testing	
15:30 – 16:00			
16:30 – 17:30	TC3: Constitutive parameter identification by multi-objective optimisation	TC3: UMAT implementation and testing	

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TC4: Constitutive modeling of advanced materials: numerical implementation and calibration through inverse analysis

Vladimir Buljak

Constitutive models provide framework for predicting structural response made of a particular material in an arbitrary context of external action. When complex materials are considered, two aspects are crucial for reliable simulations: the correct interpretation of material mechanics, commonly done through formulation of a mathematical model, and the calibration of constants entering the governing equations of previously formulated model. The course will give a theoretical overview of diverse elastic, plastic, damage and fracture models up to the level required for understanding steps for the appropriate numerical implementation. For selected models, the implementation will be discussed in more detail manner. The direct transition from measurable quantities to sought parameters is not an easy task, when governing equations are featured by an extended number of parameters. Thus, techniques based on inverse analysis apt for the quantification of these constants will be given in the course. Such methods are centered on a minimization of discrepancy function suitably selected to quantify the difference between experimentally measured and numerically computed quantities. Within the course practical examples of inverse analysis for calibration of plasticity models will be given.

References:

V. Buljak, G. Ranzi (2021). Constitutive modeling of engineering materials: Theory, computer implementation and parameter identification, Elsevier.

V. Buljak (2012). Inverse analysis with model reduction: proper orthogonal decomposition in structural mechanics. Springer Verlag.

M. Crisfield (2000). Non-linear finite element analysis of solids and structures. John Wiley and Sons.

TC3: Advanced Computational Mechanics and implementation techniques

Massimo Penasa

The lectures aim to provide an overview of the computational approaches for the modelling of materials nonlinearity and plasticity. They will cover the following topics:

- Software implementation: different programming languages, advantages and disadvantages, practical examples
- Good practices in code development: why getting the code to work is not sufficient
- Elastoplasticity: yield function, hardening, softening, examples
- Thermoplasticity and viscoplasticity: thermal softening, rate-dependent analysis, examples
- Integration algorithms for plasticity: newton method, return mapping and custom numerical strategies
- Typical elastoplastic models
- Constitutive parameter identification by multi-objective optimisation

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- Overview of different optimisation methods

CS1: Exploitation of Intellectual Property Rights

Veronique Brohez

1. Introduction to Intellectual Property: Copyright, Plagiarism, Know-How, Industrial Property (Trademarks, Designs, Patents), Databases, Domain names, Others
2. Trademarks: Definition, Filing procedures – opposition, Infringement and enforcement, Practical case study
3. Patents: Definitions, Patent, Invention, Ideas and concept, Public domain, Prior art, Freedom to operate, Patentability requirements, Novelty-inventive step-industrial application, Patent filing and prosecution, National-Regional-international routes, Opposition/invalidation, Unitary patent, Unified patent court, Infringement and enforcement, CII - Computer implemented inventions
4. Exercises and practical cases: Prior art search, How to read a patent document?, Bases for Drafting (identify what is needed to file a patent application), Infringement or freedom to operate

Vladimir Buljak: After earning a PhD in Structural Engineering at Politecnico di Milano in 2009. he stayed for additional two years as a post-doc research at the same institution. In 2011. he moved back to Belgrade where he won assistant professor position at the Department of Strength of materials, Faculty of mechanical engineering, where he is currently working as full professor since 2021. He was visiting professor at Politecnico di Milano from 2015 up to 2022. Currently he is visiting professor at BAM – German federal institute for material research and testing within German DFG program.

Massimo Penasa is co-founder and CEO of CAEmate SRL, an innovative software company focused on the development of the cloud-based platform WeStatiX for structural design, engineering workflow automation and intelligent structural health monitoring of infrastructures. He has wide experience as structural designer and project manager in international infrastructure projects. He is also a lecturer for international engineering chambers and for the courses of Computational Mechanics at the University of Trento. Dr Penasa has been responsible for tutoring a number of University students during his doctorate programme, together with teaching activities and scientific advisory.

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Veronique Brohez is a chemical engineer from the Faculte Polytechnique of Mons. She has been with the company VESUVIUS (ceramic materials for industrial use) for the last 30 years. She qualified as a Belgian and European Patent Attorney and then European Patent Litigator while working with Vesuvius. Veronique is in charge of the Corporate Intellectual Property department in Ghlin, Belgium. She manages a team of experts involved in preparing, obtaining and enforcing Intellectual Property rights. She dedicates a significant part of her time counselling the management of the firm about various issues in relation to Intellectual property. She is also a member of the Committee for the qualification of Belgian patent attorneys.

1-on-1 meetings:

Thursday 13 morning:
Lorenzo – Domagoj: COHesive elements vs. Phase Field
Kaoutar – Ilias: Digital Image Correlation

Thursday 13 afternoon:
Jovana - Lorenzo: UMAT

Friday 14 morning:
Shubhra – Domagoj: Interphase
Lorenzo – Ilias: Constitutive models

Friday 14 afternoon:
Shubhra – Kaoutar: Bi-material

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