Official RILEM EAC and TUDa Course

Computational Methods for Building Physics and Construction Materials

Hybrid!! April 7 – 11, 2025

Teachers: Prof. Dr. ir. E.A.B. Koenders, Dr. chem.-Ing. N. Ukrainczyk
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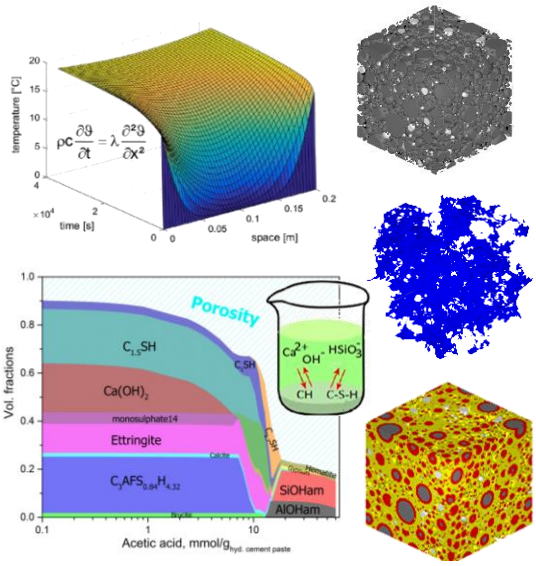
Course description:

The course contains detailed lecturing on computational methods covering differential equations, numerical solution strategies, explicit and implicit discretization, Method of Lines, boundary conditions and implementation of physical processes that frequently occur in construction materials. Emphasis will be on the Finite Difference Method applied to transport processes in porous construction materials, such as concrete and insulation materials, and on hydration modelling. Typical problems that will be addressed are thermal, moisture and reactive transport modelling, multi-layer systems, coupled moisture - heat systems, cement particle structure, hydration kinetics and thermodynamic modelling, and an introduction to high performance computing. The course provides a full solution strategy, starting from a physical problem to schematization and discretization, to boundary conditions evaluation, implementation and to a computational solution.



Key topics:

- Steady state problems – discretization and implementation in Excel
- Transient problems – explicit & implicit heat and moisture flow – implementation in Octave
- Coupled and multi-layer systems for heat and moisture flow, discretization and implementation in Octave
- Particle structure formation and hydration kinetics of cementitious systems
- Thermodynamic modelling of cement hydration with GEM-Selektor
- High Performance Computing for large multi-core systems
- Demonstrations and exercises with examples for all topics

Course program:

CMBPCM	Time	07. Apr 25 Monday	08. Apr 25 Tuesday	09. Apr 25 Wednesday	10. Apr 25 Thursday	11. Apr 25 Friday
		Basics + Explicit	Implicit - Matrix	Advanced	Cement Hydration	High Performance Computing
	8.45 - 9.00	Welcome - introduction RILEM and UNITE!				
Lectures	9.00 - 10.15	V1 Introduction schematization and discretization	V5 Transient implicit implementation in Octave	V9 Advanced time integrators and coupled systems	V13 Thermodynamic (TD) cement hydration modelling	V17 High Performance Computing Implementation
	10.15 - 10.45	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
	10.45 - 12.30	V2 Transient discretization problem, explicit method in Excel	V6 Implementation of boundary conditions and multi-layer systems in Octave	V10 Transient systems with Method Of Lines (MOL)	V14 Particle structure and cement hydration kinetics	V18 Example: Chloride Diffusion in MPI / CUDA
	12.30 - 13.30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
Demo	13.30 - 15.00	V3 Introduction to Octave and explicit transient implementations	V7 Example: Implicit Transient Implementations	V11 Example: Coupled Systems, MOL	V15 Example: cement hydration TD and Hymostruc	V19 Presentations / Feedback
	15.00 - 15.30	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
Exercise	15:30 - 17.30	V4 Programming Chloride diffusion (explicit)	V8 Programming Heat diffusion (implicit)	V12 Programming Advanced Time integrators, Heat-diffusion (MOL)	V16 Programming: Particle cement hydration (Octave)	V20 Questions / Exam Preparations

Objective:

Main objective of the course is to train MSc, PhD and Postdoc students, who are beginners or have no modelling experience, on how to solve partial differential equations and to become familiar with numerical solution strategies for common physical/chemical problems in construction materials. After finishing this course, students will be able to use computational methods for their own research and build their own basic computational models.

Venue:

The course will be provided in a hybrid format, where the actual course will take place at the TU Darmstadt and the online streaming will be offered via the platform ZOOM. A ZOOM-link will be sent shortly before every course day.

Registration fee:

Participant situation	Whole week [€]		Per day [€]	
	Online	TU Darmstadt	Online	TU Darmstadt
MSc students from TU Darmstadt, UNITE! or SPP 2436	free	free	free	free
MSc students from other Universities	75	150	30	50
PhD students and/or Postdocs	300	500	100	150
Professors or representatives from the industry	600	1000	200	300

Note: The fees already include RILEM discount.

The fee includes online course attendance, basic course materials like a PDF-copy of all PPTs, Octave, programming codes used during lectures and exercises, useful links to freeware, etc. Existing recordings of the full course will also made available for the participants via an online streaming platform until three weeks after the course.

Exam:

Non TU Darmstadt students may also opt for doing the exam. After succesful passing, a formal document confirming the 6 ECTS will be provided by TU Darmstadt. This document can be used for your graduate school.

CPD Credits:

Continuing Professional Development Credits (CPD credits) will be provided by the Institute of Concrete Technology based on the hours of participation per day.

Enrollment:

TU Darmstadt MSc students can enroll via the TU Darmstadt TUCaN system. Other MSc-, PhD-students, PostDocs, Professors, UNITE! partners, SPP 2436 or industry representatives, can enroll through the following platform:

Enrollment website: Click here

Contact information:

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Summary Course Information	**Technische Universität Darmstadt** Institute of Construction and Building Materials Campus Lichtwiese, TU Darmstadt Address: Franziska-Braun-Straße 3, 64287 Darmstadt
Exam / ECTS:	An exam will be provided / 6 ECTS
Room:	Will be announced soon
Language:	English