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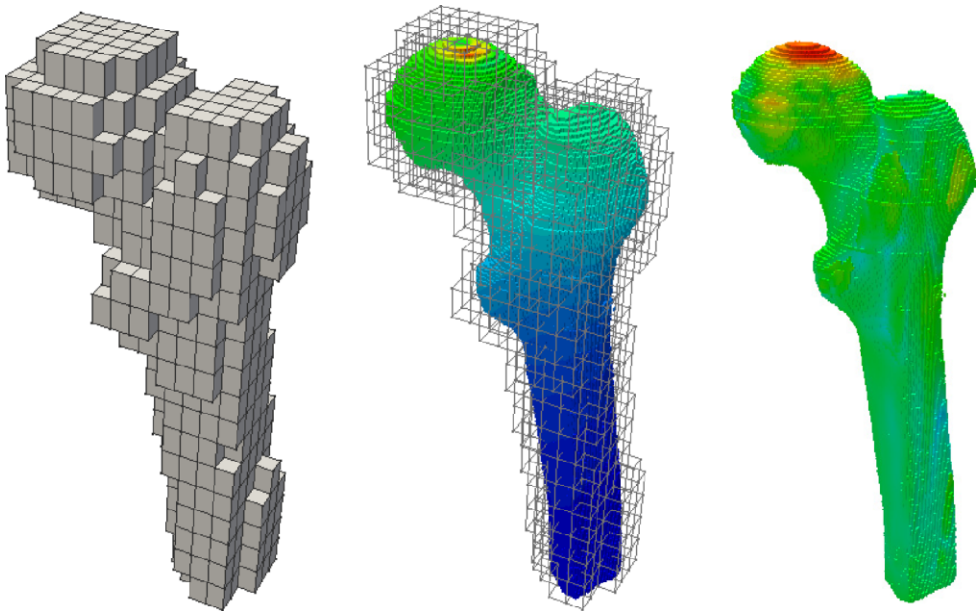
TU/e Technische Universiteit Eindhoven University of Technology
Eindhoven Multiscale Institute

Advanced School on

Immersed Methods



06-09 November 2017

Eindhoven University of Technology

Lecturers

Alexander Düster
Hamburg University of Technology

Stefan Kollmannsberger
Technical University of Munich

Mats Larson
Umeå University

Ernst Rank
Technical University of Munich

Martin Ruess
University of Glasgow

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Technical University of Denmark

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EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
TU/e Technische Universiteit Eindhoven University of Technology
TUM Technische Universität München
SPP 1748

Course description

The *Advanced School on Immersed Methods* aims to provide the participants with an introduction and comprehensive overview of the field of immersed methods (*e.g.,* the finite cell method, cutFEM, immersogeometric analysis) and their applications in fluid and solid mechanics. Immersed methods are powerful tools for solving mechanical and multi-physics problems on complex domains. The pivotal idea of these methods is to embed the complex physical domain in a larger embedding domain of simple geometry, which allows for structured meshes on which the solution fields are interpolated using higher-order bases. This approach eliminates the time-consuming and error-prone process of generating conforming meshes. Special care is required for the numerical integration of elements that intersect the boundary by means of advanced quadrature schemes. Boundary conditions are weakly imposed as the traditional strong enforcement of boundary conditions is not possible.

Topics

- General introduction to immersed methods
- Fundamental modelling aspects
- Numerical integration techniques
- Treatment of boundary and coupling conditions
- Mathematical aspects and error estimates
- Ghost penalty, conditioning and numerical solution methods
- Geometrical and image-based models
- Applications in isogeometric analysis (IGA)
- Introduction to, and applications in topology optimization
- Applications in fluid and solid mechanics

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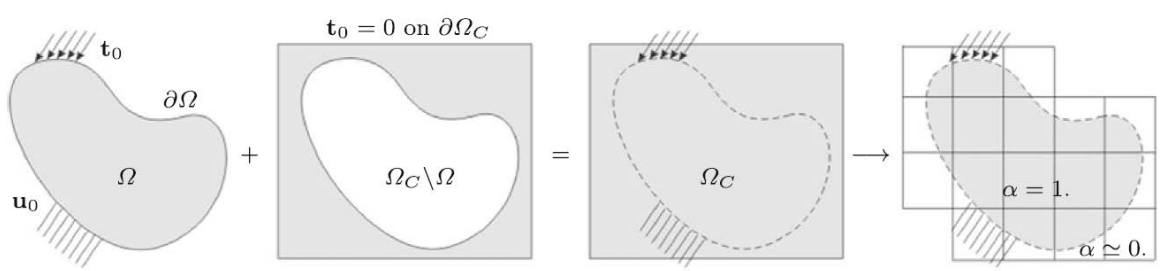
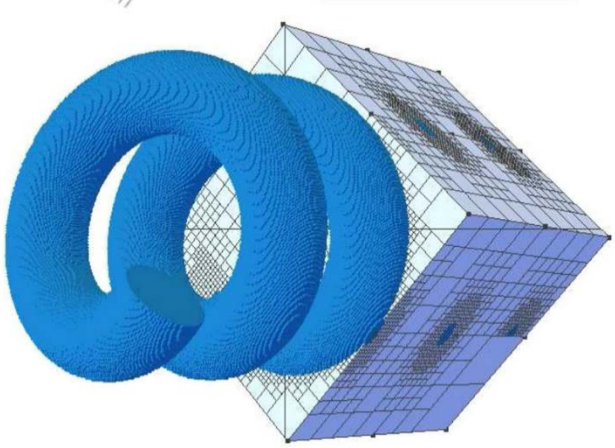
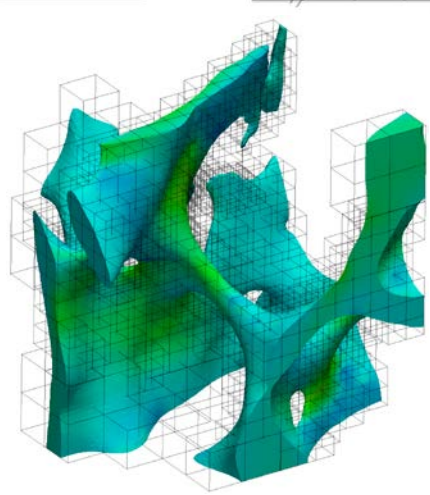






Participants

The course is aimed at PhD-students in engineering, applied mathematics and computer science specializing in the fields of solid and fluid mechanics, computational mechanics, numerical analysis of partial differential equations and scientific computing. The participants are expected to have a basic knowledge of numerical methods, in particular the finite element method.

Learning objectives

The objective of the course is to provide students with the knowledge to:

- Understand the fundamental aspects of immersed methods.
- Understand the potential advantages as well as restrictions and possible challenges that need to be dealt with.
- Assess whether immersed domain methods are beneficial in the context of their PhD-project.
- Report on currently unresolved aspects and discuss how certain scientific developments can contribute to immersed methods.

Poster session

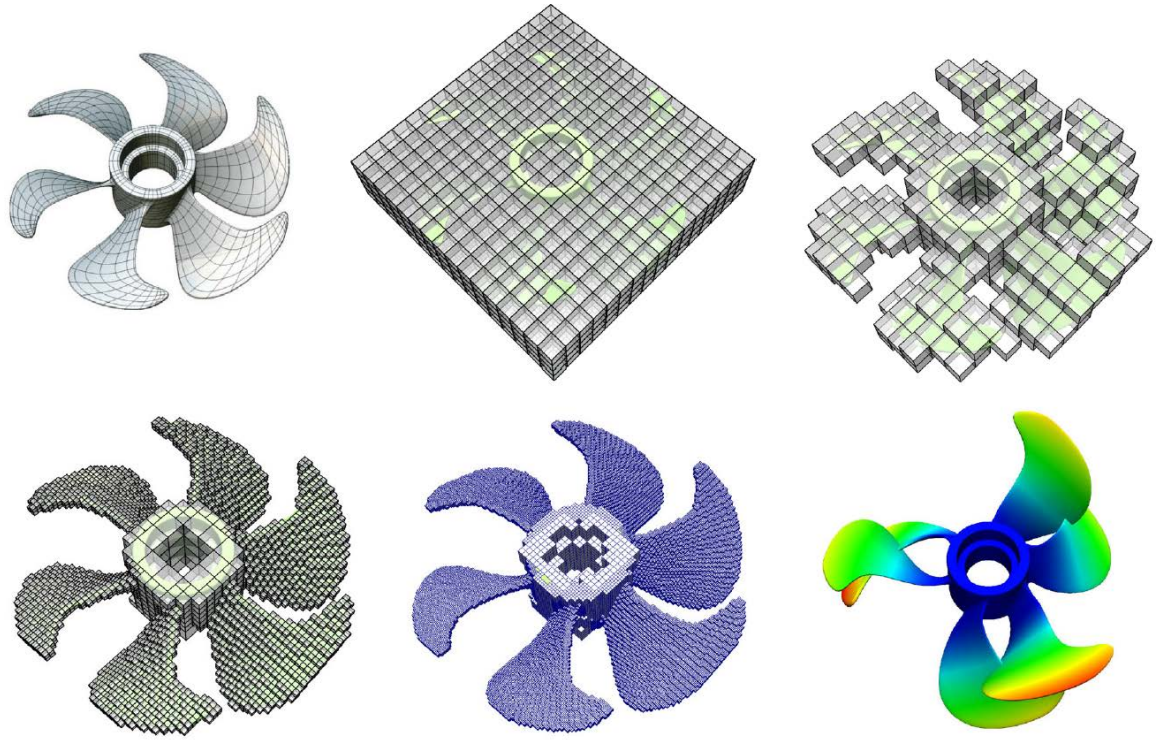
A poster session will take place on the first day of the course and serves as an informal gathering to get acquainted with other participants. The poster should provide a clear view of the students' research project and challenges. Participation in the poster session is highly recommended and is open to all registrants.

Credits and workload

A certificate of attendance is issued to all registrants attending the full program. The course is recognized by the EuroTech alliance as a **2 ECTS** course when the following conditions are met:

- Participation in the poster session
- Attendance during the full program
- Completion of an assignment related to the participant's PhD-project

The administrative processing of the credits within a participant's graduate school is the responsibility of the participant.



Organization

The course is a joint initiative of the EuroTech Universities Alliance (DTU, EPFL, TU/e, TUM) and the Eindhoven Multiscale Institute (EMI). The organizing committee is composed of:

- Frits de Prenter (TU/e)
- John Jomo (TUM)
- Jeroen Groen (DTU)

The organization committee is supported by course secretary Bianca Magielse (EMI).

Location and date

The course will take place from Monday 6 November to Thursday 9 November in the Advanced Study Center, located in the Ceres building at the Eindhoven University of Technology (TU/e) in the Netherlands.

Registration

The course fee is € 100 for students from universities in the EuroTech alliance (DTU, EPFL, TU/e, TUM) and € 150 for students from other universities. For participants from industry a fee of € 300 is charged. The fee includes participation, lunches, coffee breaks and the course dinner on the Tuesday evening. To register please complete the registration form at: www.tue.nl/emiworkshop before **October 15th 2017**.

Applicants may cancel their course registration before October 15th and receive a full refund by notifying the course secretary: emi@tue.nl. For later cancellations, a handling fee of €50 will be charged.

Travel and Accommodation

Eindhoven University of Technology is situated at walking distance from the central railway station. A direct train connection between Amsterdam Schiphol Airport and Eindhoven Central Station is available (approx. 1.5 hours). It is also worthwhile to check if a direct flight to Eindhoven Airport is available. More information on how to reach the campus is available here: https://www.tue.nl/en/university/about-the-university/accessibility-tue-campus/accessibility-route-and-map-tue-campus/towards-tue-campus/. Participants are required to arrange their own accommodation, see *e.g.,* www.booking.com.

Further information

For further information see: www.tue.nl/emiworkshop. If you have additional questions or need further assistance please contact the Eindhoven Multiscale Institute: emi@tue.nl.

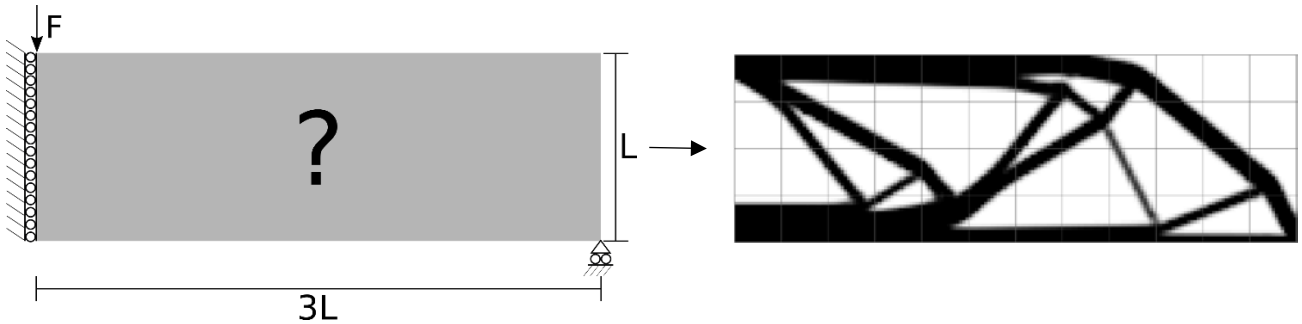


Figure sources:
Page 1, *[Ruess et al., 2013]*
Page 2, *[Ruess et al., 2012] [Ruess et al., 2013] [Verhoosel et al., 2015]*
Page 3, *[Schillinger, 2012]*
Page 4, *[Groen et al., 2016]*