UNIVERSITÀ DI TRENTO | Department of Civil, Environmental and Mechanical Engineering

Intensive course on advanced numerical methods for environmental modeling

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From Wednesday 15th to Friday 31st May 2024

On-site and **online** venue

Web page

Department of Civil and Environmental Engineering
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Summary This course on advanced numerical methods for the modeling of complex environmental processes consists of a structured intensive 2.5 week program of 80 hours of theoretical lectures and computer laboratory exercises. The focus is on advanced numerical methods for *coupled nonlinear hyperbolic and parabolic* partial differential equations with applications in environmental engineering and science. The course covers explicit and flux-splitting finite volume methods for hyperbolic equations, *semi-implicit* finite volume methods for hyperbolic and nonlinear parabolic equations, in particular the shallow water equations with *sediment transport* (shallow water Exner system), *nonlinear heat conduction* with *phase change* and moving fronts (icing and deicing, Stefan problem), the Richards equation for the description of variably saturated flows in porous media and its coupling with free surface flows to study infiltration into the soil from first principles, the compressible Navier-Stokes equations and their weakly compressible limit for the description of atmospheric flows as well as eco-morphodynamics (vegetation growth, death and mutual interaction with sediments). Special emphasis is put on the *practical implementation* of the discussed numerical methods. The lectures on the theory will be supplemented with laboratory-based computer exercises to provide hands-on experience to all participants on the practical aspects of numerical methods for hyperbolic and parabolic problems and applications using MATLAB software. The course is primarily designed for Master and Ph.D. students in applied mathematics, engineering, physics, computer science and other scientific disciplines.

* For further information on registration and payment, please reference to the **web page**, or e-mail to: Prof. Ilya Peshkov ilya.peshkov@unitn.it

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CONTENTS

Review of basic theoretical aspects of hyperbolic conservation laws and numerical concepts for hyperbolic equations. Finite volume methods for one-dimensional systems. Godunov's method. The Riemann problem and approximate Riemann solvers. Godunov-type and TVD finite volume methods for the shallow water equations. Asymptotic preserving staggered semi-implicit schemes for the compressible Euler and Navier-Stokes equations (all Mach number schemes) and their higher order extension via IMEX. Explicit and implicit schemes for diffusion. Implicit schemes for nonlinear parabolic equations (nonlinear heat conduction, Stefan problem, Richards' equation). Extension to multiple space dimensions on Cartesian grids. Numerical methods for free surface flows coupled with sediment transport and permeable bottom to account for soil infiltration (shallow-water-Exner system, shallow water equations coupled with the Richards equation). Ecomorphodynamics with applications to sediment transport and sediment transport-vegetation interaction in rivers.

FEES

- The Master and Ph.D. students of the University of Trento are free of charge.
- The external students are subjected to a tuition fee which depends on the total number of credits that you are planning to get from the course.
- The registration fee for the course is 216,00 € and includes lecturing material and MATLAB sample codes.

HOW TO ENROL

The registration **deadline** is **31st March 2024 at 12:00**.

1. Should you still not have a UniTn account, you have to register and login with your **SPID** credential (Public Digital Identity System). If you cannot use SPID, please create **your own UniTn account**.
2. Complete the online application **Apply for enrollment in 'Standard' single classes a.y. 2023/2024**
3. Please wait for the outcome of the application.
4. Pay the bulletin you find in **Esse3-Registrar's office-MyTasse**.

All information can be also found on this web page https://infostudenti.unitn.it/en/enrolment-in-standard-single-classes-2023-2024.

EXAM

The exam consists of implementing a numerical method related to the course subject and writing a 10-15 page report containing numerical results and a short overview of the employed numerical methods.

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ABOUT TRENTO AND THE DOLOMITES

The historical city of Trento is situated in the autonomous Italian region of Trentino-Südtirol, close to the world-famous mountains called Dolomites. Trento is very easy to reach by car or train from Austria (150 km south of Innsbruck) and from Verona (90 km north of Verona). The nearest and most convenient airport is Verona Airport, 15 minutes from the Verona train station. The region around Trento is of extraordinary beauty, with its unique mountains and lakes that offer the participants many exciting outdoor activities like skiing, hiking or climbing.

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