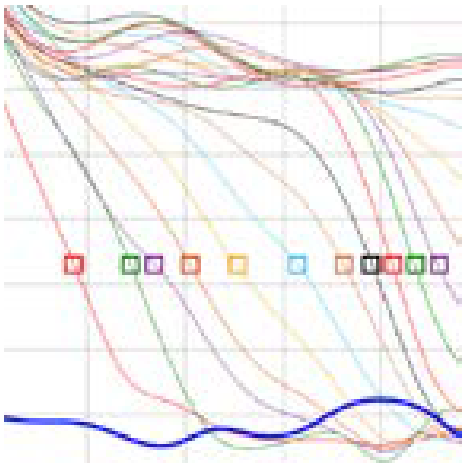
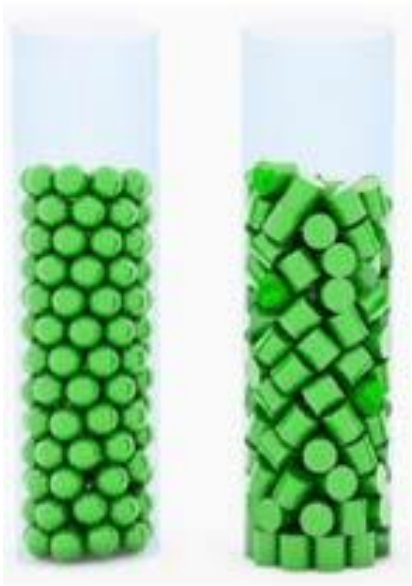
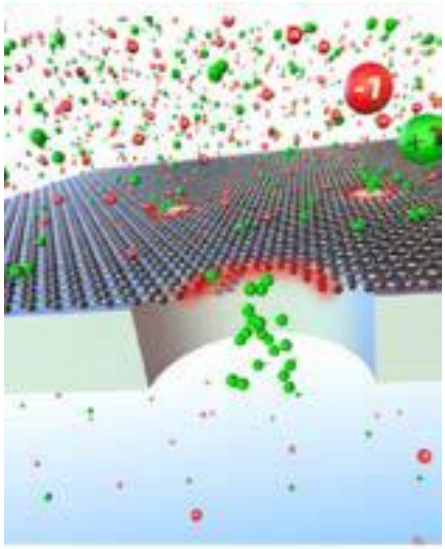


Course Programme

2022

2023





J.M.Burgerscentrum

Research School for Fluid Mechanics

Introduction

This guide provides an overview of the courses that are organised for the training of the PhD students of the JM Burgerscentrum (JMBC), the Dutch research school on fluid mechanics. The guide describes the general idea of the PhD programme and presents a framework in which individual training schedules can be developed. It gives a description of the PhD courses in the year 2022-2023, with information about the conditions to participate and instructions for registration. The courses are primarily organised for PhD students of the JMBC, although PhD students from other research schools and post-docs can also participate. Moreover, persons from industries and technological institutes are also welcome to attend the courses.

Additional information about courses and more general information about the JM Burgerscentrum can be found on our website www.jmburgerscentrum.nl.

Prof. dr. ir. Ruud A.W.M. Henkes

Scientific Director of the Burgerscentrum

Structure of the PhD programme

Purpose of the PhD programme

The purpose of the PhD programme of the JM Burgerscentrum is to help the development of PhD students into independent researchers in the field of fluid mechanics. To reach this goal a thorough and fundamental knowledge of fluid mechanics and its mathematical, physical, and numerical modelling, with experimental techniques for validation, is required. This also gives the ability to further develop this knowledge and to apply it to solve scientific and technical problems. Obviously, the main part of a PhD traject consists of the execution of a scientific research project under the supervision of an expert of the JMBC. That part is not discussed in this guide. A smaller part consists of the participation in courses. Details of that latter part (the training programme) are given in this guide.

Structure of the training programme

The training programme provides a framework, in which individual training schemes can be developed. It contains the following three components:

1. MSc courses
2. PhD courses
3. Workshops, summer schools, seminars.

The different components are meant for broadening or deepening of knowledge, and also for specialisation in certain areas of fluid mechanics. Individual training programmes are composed from elements of the three components.

MSc courses

The MSc degree fluid mechanics courses may be useful for PhD students (or other interested persons), who have had limited earlier formal training in fluid mechanics. The courses will bring those PhD students to the same level of knowledge in fluid mechanics as PhD students who did receive their MSc degree in fluid mechanics. Information about content, time and location of these courses can be found in the study guides of the different universities participating in the JMBC.

JMBC PhD courses

For a PhD student it is essential to deepen his/her knowledge in fluid mechanics to a level significantly higher than that of a person with an MSc degree in fluid mechanics. The PhD courses of the JM Burgerscentrum fulfil this purpose. The deepening of knowledge is not restricted to the specific area of fluid mechanics, to which the research project of a PhD student belongs. After obtaining his/her PhD degree, the PhD student must be able to quickly acquaint himself/herself with a new area of fluid mechanics and solve problems in that area. Therefore, each PhD student registered within the JM Burgerscentrum is expected to participate in at least three PhD courses. The content of the courses is composed in such a way that the courses can be followed by all PhD students (independent of the knowledge obtained in their MSc degree programme). The different PhD courses of the JM Burgerscentrum are usually given once every two years, depending on the number of participants. The courses are concentrated in time, usually during one week or part of a week. The courses are given by senior staff members of the JMBC, but also by (internationally well-known) guest lecturers.

The courses may contain different elements: theory, exercises with numerical simulations, numerical simulations, lab demonstrations, etc. An active role of the participants is stimulated.

Workshops, summer schools, seminars or courses of other organisations

A less-structural part of the training programme of the JM Burgerscentrum consists of workshops, summer schools and seminars. It is recommended that a PhD student registered in the JM Burgerscentrum participates in one or more (international) summer schools. Also courses organised by organisations such as the Von Karman Institute, ERCOFTAC, EUROMECH, CISM, etc. are highly recommended.

Individual training programme

For each PhD student an individual training programme has to be designed within the framework of the graduate school of the particular university at which the PhD student is working. These graduate schools provide a training in professional and personal skills, but not in the scientific expertise area in which the PhD student is working. That type of training is ideally provided by the research schools. The JM Burgers Centre provides this scientific training in the area of fluid dynamics. Although the specific requirements of the graduate schools differ from university to university, PhD students of the JM Burgers Centre are generally supposed to take at least three JMBC courses, to be selected in consultation with the supervisor. After successful course participation of the JM Burgerscentrum, the PhD student will receive a number of credit points (ECTS credits), that can be used for fulfilling the requirements in their specific graduate school programme.

JMBC certificate

After having attended at least three JMBC courses, each PhD student will receive the JMBC certificate. This document, listing the courses attended, may be helpful when applying for a job after the PhD graduation.

Course evaluation form

Each participant of a JMBC course is asked to fill in a course evaluation form via the website of the JMBC. The evaluation form is anonymous. The JMBC scientific director will discuss the evaluation results with the course leader.

Schedule of JMBC courses in 2022 – 2023

10 – 14 Oct 2022	**Particle-Image Velocimetry**	**TUD**
	Gerrit Elsinga et al.	
7 – 11 Nov 2022	**Technological innovation with fluid mechanics**	**TUD**
	Edwin Poorte	
30 Jan – 3 Feb 2023	**CFD 2**	**TUD**
	Kees Vuik and Fred Vermolen	
27 Feb – 3 Mar 2023	**Multiphase flow and phase transitions**	**UT**
	Detlef Lohse, Sander Huisman, et al.	
3 – 5 April 2023	**Shallow flows**	**VKI/TUE**
	Matias Duran Matute et al.	
12 – 14 April 2023	**Computational multiphase flow**	**TUD**
	Ruud Henkes, Wim-Paul Breugem, et al.	
June 2023	**Machine learning in fluid mechanics**	**TUE**
	Federico Toschi et al.	

Description JMBC courses in 2022 - 2023

Particle- Image Velocimetry (PIV)

10-14 October 2022
Location: TUD
Coordinators: Gerrit Elsinga (TUD), Andrea Sciacchitano (TUD)
Lecturers: Fulvio Scarano (TUD), Jerry Westerweel (TUD), Christian Poelma (TUD), Andrea Sciacchitano (TUD), Edwin Overmars (TUD), Bas van Oudheusden (TUD), Gerrit Elsinga (TUD), Rudie Kunnen (TU/e), Massimiliano Rossi (Technical University Denmark), Andreas Schröder (DLR), Ken Kiger (Maryland)

Particle Image Velocimetry is a measurement technique able to determine the instantaneous velocity field in a planar or volumetric domain. It is widely applied in both fundamental and applied fluid mechanics research. The course discusses the fundamentals of the technique and examples of specific applications, including typical problems in microfluidics, turbulence, multiphase flows and aerodynamics. Next to the lectures, a number of practical sessions will be organized, where the participants can practice their skills and see some state-of-art facilities (e.g., tomographic PIV, high-speed PIV). The course is primarily targeted at PhD students of the JM Burgerscentrum, with priority on registration. Due to limitations on the available space in the practical sessions, the maximum number of participants is set to 35. Other interested researchers (postdocs, faculty, researchers from institutes and industry) are welcome to apply as well.

Apart from a basic understanding of fluid mechanics, no prerequisite knowledge is required. The following topics are discussed:

- PIV system components: tracers, lasers, optics, cameras.
- Measurement fundamentals: cross-correlation, image density, loss-of-pairs.
- Measurement regimes: stereoscopic PIV, multiphase flows, microfluidics, high-speed systems, volumetric methods (e.g., 3D-PTV, tomographic PIV).
- Data processing techniques: multi-pass correlation, multigrid methods, deforming windows, correlation averaging, multi-frame methods.
- Data reduction and post-processing: vector validation, estimation of vorticity, detecting coherent structures, uncertainty quantification.

Experimental design and lab demos are given in practical sessions.

For more information, contact:
Gerrit Elsinga | 015 278 8179 | g.e.elsinga@tudelft.nl

Technological innovation with fluid mechanics

7-11 November 2022
Location: TUD
Coordinator: Edwin Poorte
Lecturer: Edwin Poorte

This JMBC course is centred around technological innovation. You learn to develop a new technology, based on sound fluid mechanics principles. To succeed both technically and commercially, many challenges must be overcome. The objective is to take a wild innovative idea (for example an ocean drone, an electric plane, or a brilliant idea for the energy transition) and convert this into a technically feasible technology concept, that must also become commercially viable. Many interdisciplinary issues must be overcome to succeed: technical, economical, commercial, organisational, political and related to society. Close collaboration in an empowered and motivated innovation team is required to overcome blockers of progress.

Some 30% of this course is 'lecturing style format', where all relevant aspects of technological innovation will be covered. Some 40% of the course is in 'workshop format', where teams of participants will grasp the topic just covered in a lecture, by applying it to their technological innovation concept. Learning-by-doing requires close collaboration. The course instructor will facilitate each team such that creative and valuable ideas are included into the technology concept. The remaining about 30% of the course is 'interactive sessions', where participants openly exchange views on several aspects of technological innovation. This interaction allows to make the course highly relevant for the ongoing PhD project of a participant, or for future innovation endeavours as part of an aspired industrial career.

The various skills acquired in this course will be highly valuable for:

- PhD students that are working on an experimental topic in fluid mechanics (which requires to be innovative to develop the best possible experimental set-up);
- PhD students that have an ambition for an industrial career based on fluid mechanics and innovation;
- Industry participants that want to develop professionalism in technological innovation.

For more information, contact:
Edwin Poorte | 0638342806| Edwin@troyka-innovation.com

CFD 2

30 January - 3 February 2023
Location: TUD
Coordinator: Kees Vuik (TUD)
Lecturers: Kees Vuik (TUD), Fred Vermolen (Hasselt University, B)

This lecture course focuses on (i) finite element methods for the incompressible Navier-Stokes equations and on (ii) iterative solution methods. The course consists of two parts:

(1) A short introduction to the finite element method is given. The following fluid flow applications are used: Poisson equation, convection-diffusion equation and the incompressible Navier-Stokes equations. Subjects studied in more detail are: (streamline) upwind methods, problems originating from the incompressibility condition, and the linearisation of convective terms in the Navier-Stokes equations. Some remarks are given on time-dependent problems.
(2) The second part of the course is devoted to modern iterative methods. Furthermore, the following related topics are considered:

- direct and iterative methods for (sparse) linear systems;
- iterative methods to compute eigenvalues of matrices;
- implementation of these methods on vector- and parallel computers.

As applications systems are used which originate from fluid flow problems. To illustrate the theory, practical work is done in the afternoons using MATLAB and the finite element package SEPRAN. Required background: a basic course in numerical analysis, partial differential equations and linear algebra.

For more information, contact:
Kees Vuik | 015 278 5530 | c.vuik@tudelft.nl

Multiphase flow and phase transitions

27 February – 3 March 2023
Location: University of Twente
Coordinators: Detlef Lohse and Sander Huisman (UT)
Lecturers: Detlef Lohse (UT), Sander Huisman (UT), Bert Vreman (TUE), Johan Padding (TUD), Christian Poelma (TUD), Federico Toschi (TUE), et al.

Multiphase flow has become one of the core disciplines in fluid dynamics, due to its fundamental challenges and due to its relevance in industry. This includes (turbulent) bubbly flow, flow with droplets, and flow with particles, the latter two in both liquid and gas as carrier. The Dutch Fluid Dynamics Groups of the JM Burgers Centre have traditionally been strong in this area and many PhD students work in the field. The idea of the course is to offer them an overview on experimental, numerical and theoretical concepts in this topical and relevant research field. The lecturers are leaders of the involved research groups.

For more information, contact:
Detlef Lohse | 053 489 8076 | d.lohse@utwente.nl

Shallow flows

3 - 5 April 2023
Location: VKI, Brussels (B)
Coordinator: Matias Duran Matute (TUE)
Lecturers: GertJan van Heijst (TU/e), Huib de Swart (UU), Wim Uijttewaal (TUD), Theo Gerkema (NIOZ), Scott Socolofky (Texas A&M), Anne Lightbody (University of New Hampshire), Matias Duran Matute (TU/e).

Many flows in environmental and in industrial situations can be characterised as ‘shallow’, with the horizontal scales being essentially larger than the vertical size of the flow domain. Examples are flows in rivers, estuaries, the coastal region, harbours, fresh water reservoirs, but also in settling chambers for water treatment. Shallowness implies a rather specific flow dynamics.
The purpose of this Lecture Series is to offer an overview of various aspects of shallow flows: fundamental as well as applied aspects, and numerical modelling as well as laboratory studies and field observations. Topics that will be addressed in the Lecture Series are, for

example, laboratory and numerical studies of fundamental physical processes and transport mechanisms in shallow mixing layers, wakes, jets, and open channels. Also, transport of heat, solutes, and pollutants in canonical shallow flows and generic flow configurations will be discussed. Other topics are: interaction with vegetation, sediment transport and morphodynamics, which are relevant features of environmental shallow flows, such as occurring in the coastal area, estuaries, harbours and in rivers.
The course will be delivered by a number of internationally recognized experts. The aim of this course is to give a wide overview of various aspects of shallow flows. No specific prior knowledge of geophysical or environmental fluid dynamics is required, although it is assumed that the participants have a general background in fluid dynamics.
The Lecture Series Director is Professor Matias Duran Matute from TU Eindhoven and the local coordinator is Professor Jeroen van Beeck from the von Karman Institute for Fluid Dynamics.

For more information, contact:
Matias Duran Matute | 040 247 2118 | m.duran.matute@tue.nl
See also the website of the Von Karman Institute:
Lecture Series - Shallow Flows (vki.ac.be)
PhD students and postdocs of the Burgerscentrum can register through the website of the VKI (they pay the reduced JMBC fee of 250 Eur and get their travel and hotel costs reimbursed through the JMBC).

Computational multiphase flow

12 - 14 April 2023
Location: TUD
Coordinator: Ruud Henkes (TUD)
Lecturers: Wim-Paul Breugem (TUD), Ruud Henkes (TUD), Jim Kok (UT), Hans Kuipers (UT), Luis Portela (TUD), Kees Vuik (TUD)

Multiphase flow denotes the combined transport of gas, liquid, and particles. The aim of this 3-day course is to give a broad overview of the possibilities and limitations of physical-numerical modelling and prediction of multiphase flows. This includes (1) fundamentals of physical models and their numerical representation and solvers, (2) application of Computational Fluid Dynamics to a wide range of environmental and industrial processes driven by multiphase flow, (3) assessment of a number of CFD packages widely used to solve industrial problems. At the end of the course the participants will have a good awareness of the types of computational methods, with their specific accuracy, that can be used for multiphase flows occurring in industry. This will help them to build realistic expectations for their own specific practical problems, which might be even more complex than the examples treated in the course. Participants will also be able to acknowledge gaps in our current knowledge, which may help them to define new future research directions.

For more information, contact:
Ruud Henkes | 0652096201 | r.a.w.m.henkes@tudelft.nl

Machine learning in fluid mechanics

June 2023
Location: TUE
Coordinators: Federico Toschi (TUE), Alessandro Corbetta (TUE)
Lecturers: Federico Toschi (TUE), Alessandro Corbetta (TUE), and others

Machine learning and deep learning are allowing the progressive automation of tasks that only few years ago were impossible or required labour-intensive human activity. Image processing, language processing/translation, automated control, digital pathology are examples of recently revolutionized sectors. From a scientific perspective, there are strong evidences that deep learning methods are much better capable of quantifying properties of complex and/or chaotic dynamical systems, among which turbulence, than the current conventional state-of-the-art methods. This opens new research possibilities in which machine learning supports, or even unlocks, new scientific discoveries. This course, aimed at students with a fluid mechanics background, has a two-fold aim: first it will provide an application-oriented primer on neural networks for inference and control tasks, and second it will present recent selected use-cases from fluid mechanics and non-linear dynamics. The course time will be evenly split between lectures and hands-on sessions. Students will be trained to state-of-the-art machine learning software tools (python/jupyter, keras).

For more information, contact:
Federico Toschi | 040 247 3911 | f.toschi@tue.nl

Registration for JMBC courses

Conditions

The PhD courses organised by the JM Burgerscentrum are primarily organised for the PhD students of the JM Burgerscentrum. They have priority with respect to registration for these courses. However, also PhD students from other research schools, post-docs and staff members from industries and technological institutes can participate.

Fees

€ 250 | Officially registered JMBC PhD students and JMBC Postdocs.
Registration fee includes: course material, lunches, a joint diner, and (if necessary) hotel accommodation. The hotel (if necessary) will be booked and paid by the JMBC.

€ 400 | All other national and international PhD students, scientific staff, postdocs, post-graduate students. Registration fee includes: course material, lunches, a joint diner. Participants have to book their own hotel accommodation; no reimbursement is provided by the JMBC.

€ 1000 | Staff members from industries, technological institutes or other participants. Registration fee includes: course material, lunches, a joint diner. Participants have to book their own hotel accommodation; no reimbursement is provided by the JMBC.

Registration

Registration for the JMBC PhD courses is possible by filling in the online registration form on the website of the Burgerscentrum:
Registration PhD courses for JMBC members | JM Burgerscentrum
Registration PhD courses for non-JMBC members | JM Burgerscentrum

Certificate of attendance

Directly after completing the course, each participant in a JMBC course will receive from the JMBC secretariat a “certificate of attendance” confirming his/her participation. Note that the full “JMBC certificate” is only obtained after having attended at least three JMBC courses.




JMBC Course Programme

2022 - 2023