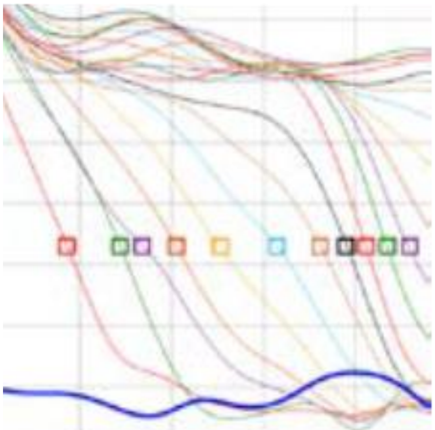
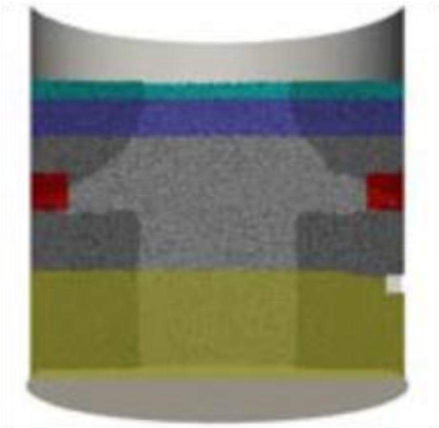
Course Programme





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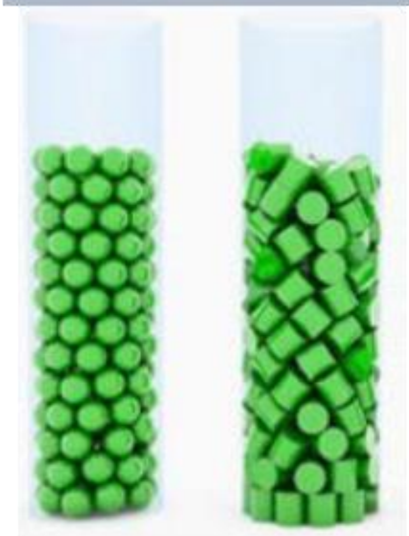

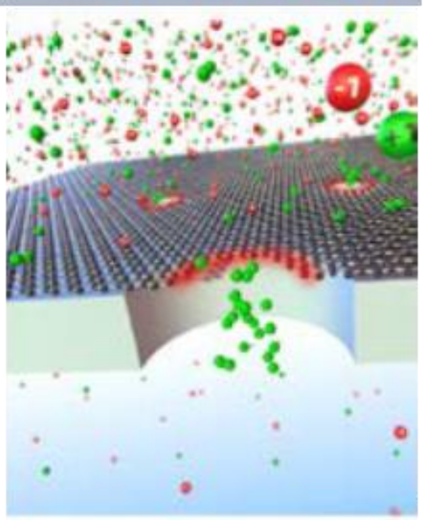

J.M. Burgerscentrum

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 J.M. Burgerscentrum (JMBC), the Dutch research school for 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 2024-2025, 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, people 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 Burgerscentrum Courses.

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 J.M. 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 studies 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 of 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 J.M. Burgerscentrum fit 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 J.M. 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 J.M. Burgerscentrum are usually given once every two years, depending on the number of participants. The courses are concentrated in time, usually lasting 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 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 Burgerscentrum 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 J.M. 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 2024 – 2025

7 – 11 Oct 2024	**Active hydrodynamics**		**WUR**
		Udo Sen and Corinna Maass	
4 – 7 Nov 2024	**Experimental techniques in fluid mechanics**		**UT**
		Alvaro Marin and Michel Versluis	
11 – 15 Nov 2024	**Technological innovation with fluid mechanics**		**TUD**
		Edwin Poorte	
27 – 31 Jan 2025	**CFD 2**		**TUD**
		Kees Vuik and Fred Vermolen	
Feb 2025	**Combustion**		**TU/e**
		Rob Bastiaans, Jeroen van Oijen, et al.	
31 Mar – 4 Apr 2025	**Wake flows**		**TUD**
		Fulvio Scarano, Bas van Oudheusden, et al.	
28 Apr – 2 May 2025	**Multiphase flow and phase transitions**		**UT**
		Detlef Lohse, Sander Huisman, et al.	
Q2 2025	**Fluid dynamics in sustainable energy**		**TU/e**
		Yali Tang, Richard Stevens, Willem Haverkort et al.	

Description JMBC courses in 2024 - 2025

Active Hydrodynamics

7-11 October 2024
Location: Wageningen
Coordinators: Uddalok Sen (WUR) and Corinna Maass (UT)
Lecturers: Jacco Snoeijer, Mazi Jalaal, Hartmut Löwen, Marjolein Dijkstra, Alvaro Marin, Silke Henkes, Alexandre Morin, Matan Ben Zion, Luca Giomi, Idan Tuval, Daniel Tam, Chase Broedersz, Florian Muijres

Active matter systems are ubiquitous nonequilibrium condensed systems composed of self-driven (active) units capable of converting (stored or ambient free) energy into motion. These active units often interact with each other and/or interact with the ambient medium, which sometimes leads to the emergence of collective motion. The most commonly observed active matter systems are observed in biology, but there have been significant advances in so-called `synthetic active matter' over the past decade as well. Active matter systems can be broadly classified into two groups: 'dry active matter' (where hydrodynamic interactions with the ambient are unimportant), and 'wet active matter' (where hydrodynamic interactions with the ambient must be taken into account). Finally, active units at sufficiently high density can be regarded as intrinsically active fluids via continuum theories.

The course will focus on 'wet active matter', and will offer a fundamental introduction into activity at primarily low Reynolds numbers, hydrodynamic interactions of active agents with each other and their environment, and the implications for their dynamics and emergent behaviour. To familiarize course participants from the fluid dynamics community with general concepts in active matter, there will also be one introductory lecture on what is active matter, followed by one on 'dry active matter' (where hydrodynamic interactions are not important). These will be followed by lectures on the essential theoretical, modeling, and experimental techniques, before delving deeper into the details of specific cases of hydrodynamics in both synthetic and biological active matter systems. As part of the course, the participants will also have to perform a mini-project/case study on topics at the frontier of this rapidly evolving field. Finally, there will also be a panel discussion focusing on scenarios where one can ignore hydrodynamics and where it is absolutely crucial.

For more information, contact:
Uddalok Sen | uddalok.sen@wur.nl

Experimental techniques in fluid mechanics

4 – 7 November 2024
Location: UT
Coordinators: Alvaro Marin (UT), Michel Versluis (UT)

Lecturers: Nico Dam (TU/e), Fulvio Scarano (TUD), Jan van Dijk (TU/e), Michel Versluis (UT), Alvaro Marin (UT), Christian Poelma (TUD), Willem van de Water (TUD), Rudie Kunnen (TU/e)

This course for JMBC PhD students gives a general overview of concepts of experimental methods for flow, pressure, concentration and temperature measurements. The course will discuss various classic techniques (thermocouples, Pitot tubes, hot-wire anemometry) and optical techniques such as shadowgraphy and Schlieren. The course will also focus on modern non-intrusive laser techniques (Laser Doppler and Phase Doppler Anemometry, Particle Imaging and Particle Tracking Velocimetry and Laser-Induced Fluorescence). We will discuss methods for flow visualization and high-speed imaging and we have special presentations on experimental methods used in two-phase flows, in rheology and in industrial applications.

For more information, contact:
Michel Versluis | 053 489 6824 | m.versluis@utwente.nl
Alvaro Marin | 053 489 2379 | a.marin@utwente.nl

Technological innovation with fluid mechanics

11-15 November 2024
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 in 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

27 – 31 January 2025
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

Combustion

5 days in February 2025
Location: TUE
Coordinators: Rob Bastiaans and Jeroen van Oijen (TUE)
Lecturers: The lectures are given by the members of the organizing committee, complemented by specialists for the various topics (lecturers from both inside and outside the Netherlands. In particular, internationally well-known specialists will be invited to present recent developments in the field.

The objective of this 5-day course is to bring the participants to the forefront of modern computational and experimental methods for premixed and non-premixed gaseous combustion processes. It starts with the provision of basic insight into the underlying physical/chemical principles and mathematical descriptions. Thereafter, specific attention is given to carbon neutral energy harvesting, looking at conversion of H2, NH3, methanol, metals, etc., with inclusion of practical applications. As was the case for previous editions of the course, the course is again organised under the auspices of the J.M. Burgers Centre and ERCOFTAC. The target audience are PhD students, postdocs and also industrial researchers needing education in experimental and modelling approaches to both laminar and turbulent flames.

The course programme includes:

- The governing equations for chemically reacting flows, state-of-the-art models will be derived for laminar and turbulent flames, by means of which their physical and chemical behaviour will be analysed.
- Computational issues for modelling these systems numerically will be discussed as well.
- A further focus is on the use of laser-diagnostic methods, such as LIF, Raman, CARS, and PIV, to measure local species concentrations, temperatures and flow velocities in high-temperature, chemically reacting flow systems.
- Combustion of liquid and solid fuels will be discussed.
- Practical applications will be studied for a number of examples, such as IC engines, gas turbines and furnaces.
- The theory is tested and illustrated with numerical exercises using a code for modelling elementary 1D-flame structures.
- A visit to the labs of the Power and Flow (P&F) group is planned for the second day.

For more information, contact:

Rob Bastiaans | r.j.m.bastiaans@tue.nl

Wake flows

31 March – 4 April 2025
Location: Delft University of Technology
Coordinators: Fulvio Scarano and Bas van Oudheusden (TUD)
Lecturers: Various

This 5-day course will focus on:

- The essential concepts of wake flows and their relevance
- The various important characteristics of wake flows and their impact (momentum deficit, drag, unsteadiness, vorticity)
- The commonalities as well as differences for wakes in various technology domains
- The fluid-dynamic background of the origin of wake formation (separation, effect of viscosity, instability); effect of Reynolds number (+ Mach, Froude)

List of lecturers (intended):

- Fulvio Scarano (Coordinator, TUD-AE – Aircraft wakes, transitional jets)
- Bas van Oudheusden (Coordinator, TUD-AE – Lifting line theory, aerodynamic theories)
- David Rival (TUB-Braunschweig – Bio fluid mechanics, unsteady wakes)
- Jerry Westerweel (TUD-ME – Turbulence, unsteady hydrodynamics, rowing)
- Gaby Weymouth (TUD-ME – Marine hydrodynamics, flapping foils, bio-propulsion)
- Andrea Sciacchitano (TUD-AE – Sport aerodynamics & bluff bodies)
- Tom van Terwisga (TUD-ME – Ship hydrodynamics, maritime propulsion)
- Marc Gerritsma (TUD-AE – Aviation aerodynamics, compressible flows)
- Carlos Simao Ferreira (TUD-AE – Rotor aerodynamics, wind turbines)
- Bert Blocken (KU Leuven – Wind engineering, sport aerodynamics)
- Florian Muijres (WUR Wageningen – bio-propulsion, flapping wing aerodynamics)
- Theodoros Michelis (TUD-AE – Aerodynamic flow control)

The course also includes a wakes workshop.

For more information, contact:
Fulvio Scarano | f.scarano@tudelft.nl

Multiphase flow and phase transitions

28 April – 2 May March 2025
Location: University of Twente
Coordinators: Detlef Lohse and Sander Huisman (UT)
Lecturers: Kay Buist (TUE), Christian Diddens (UT), Valeria Garbin (TUD), Sander Huisman (UT), Mazi Jalaal (UVA), Angeliki Laskari (TUD), Morgan Li (TUD), Detlef Lohse (UT), Corinna Maaß (UT), Alvaro Marin (UT), Johan Padding (TUD), Christian Poelma (TUD), Noushine Shahidzadeh (UVA), Federico Toschi (TUE), Roberto Verzicco (UT), Bert Vreman (TUE), Jeff Wood (UT), Rui Yang (UT).

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 of 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

Fluid dynamics in sustainable energy

4 days in Q2 2025
Location: Eindhoven University of Technology
Coordinators: Yali Tang (TU/e), Richard Stevens (UT), Willem Haverkort (TUD)
Lecturers: Various

For more information, contact:
This 4-day course gives an overview of how knowledge on fluid dynamics is essential in the design and operation of sustainable energy systems. Think of: wind, thermo-solar, and tidal energy, electrolysis & hydrogen technology, catalysis and batteries, heat storage, etc.

Various experts on the following topics will provide lectures:

- General introduction on the challenges of the energy transition on the different scales involved.
- General introduction on the underlying basic questions: role of fluid dynamics and transport phenomena on the different scales involved.
- Fluid dynamics in wind energy.
- Fluid dynamics of floating wind turbines.
- Fluid dynamics in electrolysers.
- Fluid dynamics in CO2 capture and transport.
- Fluid dynamics in hydrogen transport.
- Fluid dynamics in metal fuels.
- Fluid dynamics in hydrogen combustion.
- Fluid dynamics in thermal energy storage and transport.

For more information, contact:
Yali Tang | Y.Tang2@tue.nl

Registration for JMBC courses

Conditions

The PhD courses organised by the J.M. Burgerscentrum are primarily organised for the PhD students of the J.M. 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 course dinner, and (if necessary) hotel accommodation. The hotel (if necessary, with a maximum of 130 Eur/night) will be paid for by the JMBC (after the course one should send invoices for travel and hotel accommodation to jmburgerscentrum@tudelft.nl, with name, home address, and bank account).

€ 400 | All other national and international PhD students, scientific staff, postdocs, post-graduate students. Registration fee includes: course material, lunches, and a course dinner. 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. The registration fee includes: course material, lunches, and a course dinner. 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:
PhD courses for JMBC members
PhD courses for non-JMBC members

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

2024 - 2025