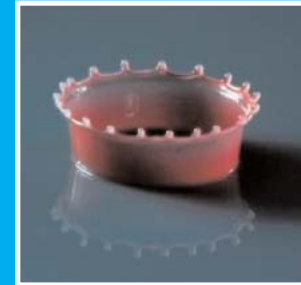


Cover

A Splash of Red

Not the ordinary splash.
A 2-mm droplet of red dye impacting on a thin layer of milk.
High-speed photography reveals crown formation with tips of entrained milk covering the rim of the coronet. Jets extend from the tips, breaking up the white satellite droplets with a splash of red.

W van Hoeve
University of Twente



2009 - 2010

Course Programme

J.M. Burgerscentrum

Research School for Fluid Mechanics
TUD, TUE, UT, RUG, RUN, UL, WUR, UU

Course Programme 2009 - 2010

JM Burgerscentrum
Research School for Fluid Mechanics

TUD, TUE, UT, RUG, RUN, UL, WUR, UU

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Correspondence for reproduction: JM Burgerscentrum, attn. Mrs. I Hoekstein, Mekelweg 2, 2628 CD Delft, The Netherlands

Phone 015 278 3216 or Fax 015 278 2979

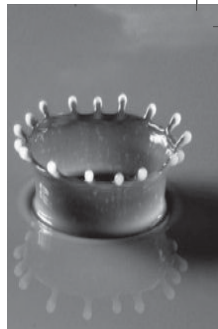
E-mail address: jmburgerscentrum@tudelft.nl

<http://www.jmburgerscentrum.org>

Produced by : Prof.dr.ir. G Ooms and Mrs. I Hoekstein of the JM Burgerscentrum

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Contents

Introduction **10**

Structure of the PhD programme

Purpose of the PhD programme	12
Structure of the training programme	12
MSc degree courses	12
JMBC PhD courses	13
Workshops, summer schools, seminars or courses of other organisations	13
Individual training programme	14
Career orientation	14

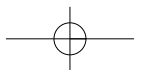
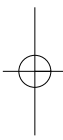
Registration for JMBC PhD Courses

Conditions	16
Fees	16
Registration	16
Certificate	16
Course evaluation form	17

Course Programme 2009 - 2010

JMBC PhD courses	
♦ Geophysical fluid dynamics and 2D turbulence	20
♦ PIV Delft	21
♦ CFD 1	21
♦ Granular matter	22
♦ Computational multiphase flow	22
♦ Experimental techniques	23
♦ Cardiovascular in-vitro and ex-vitro experimental techniques	23
♦ Particle technology	24

JMBC PhD courses in cooperation with other organisations	
♦ PIV Göttingen	25
♦ OSPT Courses	26
♦ ERCOFTAC Courses	26
♦ Von Karman Institute Courses	26
 MSc degree Courses	
♦ General fluid mechanics	27
♦ Compressible flows	28
♦ Multiphase flow, dispersed media and rheology	30
♦ Numerical computations and modelling	34
♦ Theory of chaos and dynamical systems	38
♦ Combustion	40
♦ Turbulence	44
♦ Waves and free surface flows	46
♦ Micro-scale fluid mechanics	50
♦ Experimental techniques in fluid mechanics	51
 Who and Where	 53
 Registration form only for JMBC PhD Courses	 61



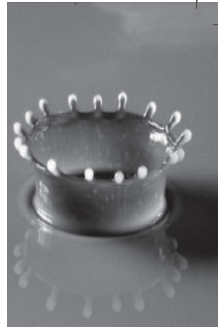


Introduction

Introduction

This is the guide for the training programme especially developed for the training of the PhD students of the JM Burgerscentrum, 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 courses in the year 2009-2010, with information about the conditions to participate and instructions for registration. As mentioned, the courses are in particular meant for PhD students of the JMBC. However, also PhD students from other research schools and post-docs can participate. Moreover, persons from industries and technological institutes can also attend the courses. Additional information about the courses will be announced in the JMBC Newsletter, which appears three times per year. Information about courses and more general information about the JM Burgerscentrum can also be found on our website www.jmburgerscentrum.org

Prof.dr.ir. G Ooms
Scientific director



Structure of the PhD programme

Structure of the PhD programme

Purpose of the PhD programme

The purpose of the PhD programme of the JM Burgerscentrum is 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 their mathematical and numerical modelling is required, as well as the ability to further develop this knowledge and to apply it to solve scientific and technical problems. An important part of the PhD programme consists of the execution of a scientific research project under the supervision of an expert of the JM Burgerscentrum. That part is not discussed in this guide. A smaller part, of the order of half a year, consists of the participation in courses. The details of that part of the programme (the training programme) are given in this guide.

Structure of the training programme

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

- ♦ MSc degree courses
- ♦ PhD degree courses
- ♦ 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. In the next paragraphs the three components are discussed.

MSc degree courses

The MSc degree courses are meant for PhD students (or other interested persons), who have no 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. The courses are usually selected from the advanced courses of the study programme for the MSc degree. An overview of the most relevant MSc degree courses are given in this guide ordered according to the main research themes of the JMBC. Information about time and place of these courses can be obtained from the contact persons mentioned in the course descriptions given in this guide, or can be found in the study guides of the different universities participating in the JMBC.

The number of ECTS points for the MSc degree courses to be included in an individual training programme depends on the MSc study programme of the individual. Usually it is about 9 to 15 ECTS points (each ECTS point is approximately 27 hours of study for the PhD student).

JMBC PhD courses

For a PhD student it is essential to deepen his knowledge in fluid mechanics to a level significantly higher than that of a person with a MSc degree in fluid mechanics. The PhD degree courses of the JM Burgerscentrum fulfil this purpose. The deepening of knowledge is not restricted to the area of fluid mechanics, to which the research project of a PhD student belongs. The idea of the PhD degree courses is to continue the formal training of the PhD student in a number of areas in the field of fluid mechanics, but on a post-graduate level. After his PhD degree the PhD student must be able to quickly acquaint him (her) self with a new area of fluid mechanics and solve problems in that area. As a consequence each PhD student must at least participate in three PhD degree courses. In consultation with the supervisor a PhD student can decide to follow more courses. The number of ECTS points connected to the PhD degree courses must at least be 9. The content of the courses is composed in such a way, that the courses can be followed by all PhD students (independent of their knowledge from their MSc degree programme).

The different PhD degree courses of the JM Burgerscentrum are usually given once every two years, dependent on the number of participants. The courses are concentrated in time, usually during one week. The courses are given by the senior staff members of the JMBC, but also by (internationally well-known) guest lecturers. They determine the number of ECTS points for their course. The courses can contain several elements: theoretical training, own work, demonstrations, etc. An active role of the participants is stimulated.

Workshops, summer schools, seminars or courses of other organisations

Besides MSc degree courses and PhD degree courses there is also a less-structural part of the training programme of the JM Burgerscentrum, consisting of workshops, summer schools and seminars. They can be very valuable for the education of the PhD student, and will usually be in the area of fluid mechanics to which the research project of the PhD student belongs. It is, in particular, recommended that a PhD student participate in summer schools. The JM Burgerscentrum organises regularly a summer school in a different area of fluid mechanics. Another component can be courses, not organised by the JM Burgerscentrum but by another organisation (courses from the Von Karman institute, ERCOFTAC, EUROMECH, etc.). The number of ECTS points of this part of the training programme will on average be 9.

Individual training programme

The total training load per PhD student is approximately 30 ECTS points. Deviations are of course possible; a minimum of 22.5 ECTS points is necessary, there is a maximum of 37.5 ECTS points. Taking these rules into account an individual training programme can be scheduled by a PhD student in consultation with his(her) supervisor. The programme gives a listing of the components and their timing. It is recommended to set-up the programme during the appointment of the PhD student. The supervisor decides, whether exams about the followed courses are necessary. (Each PhD course counts for 3 ECTS points)

*An example of a training programme (for a PhD student **without** a fluid-mechanics background) is as follows:*

1 st year	MSc degree courses	12 ECTS points
	PhD degree courses	6 ECTS points
	Workshop, etc.	1.5 ECTS points
2 nd year	PhD degree courses	3 ECTS points
	Workshop, etc.	1.5 ECTS points
3 rd year	Workshop, etc.	3 ECTS points
4 th year	Workshop, etc.	3 ECTS points

*An example of a training programme (for a PhD student **with** a fluid-mechanics background) is as follows:*

1 st year	PhD-degree courses	9 ECTS points
	Workshop, etc.	1.5 ECTS points
2 nd year	PhD-degree courses	9 ECTS points
	Workshop, etc.	1.5 ECTS points
3 rd year	Workshop, etc.	3 ECTS points
4 th year	Workshop, etc.	3 ECTS points

Career orientation

It is important that PhD students prepare themselves well for their future job after finishing their PhD project. Therefore each PhD student selects in consultation with his/her supervisor a course dedicated to 'career orientation' and follows this course during the third or fourth year of his/her project. Such courses are given by universities and by FOM. Via the websites of universities and FOM more details about the courses can be found. As examples some web addresses are given below:

TUD www.tudelft.nl/tumobiel

TUE http://w3.tue.nl/en/services/dpo/career_and_development/phd_students/career_development/

UT www.utwente.nl/cursusaanbod/thema/ontwikkeling/loopbaan

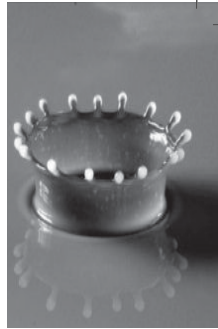
RUG www.rug.nl/medewerkers/voorzieningen/cursussen/cursussenMenO/cursussen/careerPlanning

RUN www.ru.nl/studenten/na_je_studie/inleiding/na_je_studie/

UL www.bul.leidenuniv.nl/

WUR www.phd.wu.nl

FOM/STW www.fom.nl (search for "Brochure Plan uw Toekomst")



Registration for JMIBC PhD courses

Registration for JMBC PhD courses

Conditions

The PhD degree courses organised by the JM Burgerscentrum are in the first place meant for the PhD students of the JM Burgerscentrum. They have priority with respect to registration for these courses. However, as mentioned, also PhD students from other research schools, post-doc's and staff members from industries and technological institutes can participate.

Fees

- ♦ *Officially registered PhD students of the JM Burgerscentrum*
150,- Euro per course. Incl. course material, lunches, diner, travel expenses, and (if necessary) hotel accommodation.
- ♦ *Other PhD students, scientific staff, post doc's, post-graduate students from universities*
150,- Euro per course. Incl. course material, lunches and diner.
Travel expenses and hotel accommodation are not included.
- ♦ *Staff members from industries, technological institutes, or other interested persons*
250,- Euro per course. Incl. course material, lunches and diner.
Travel expenses and hotel accommodation are not included.

Registration

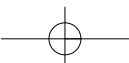
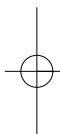
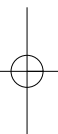
Registration is possible by filling in the hard copy registration form (given in this guide) and sending it to the JMBC secretariat or by online registration on www.jmburgerscentrum.org (Registration). The registration form is only necessary for the JMBC PhD courses. For OSPT, ERCOFTAC, PIV and Von Karman Courses, information about the contents and how to register can be obtained directly with these organisations.

Certificate

At request a participant in a JMBC course can receive from the JMBC secretariat a certificate concerning his/her participation.

Course evaluation form

Each participant of a JMBC course will receive from the JMBC secretariat a hard copy of the course evaluation form with the request to fill it in as soon as possible and to send it back to the JMBC secretariat. There is also the possibility to fill in the form via the website of the JMBC www.jmburgerscentrum.org (Registration). The evaluation form is anonymous. The JMBC scientific director will discuss the evaluation results with the course leader.





Course Programme 2009 - 2010

JMBC PhD courses

*Registration via the JMBC Secretariat (see enclosed registration form) or online via
www.jmburgerscentrum.org (Registration)*

Registration preferably one month before the start of the course

Overview of the courses for the academic year 2009-2010

- | | |
|------------------------|--|
| ♦ 21-24 September 2009 | Geophysical fluid dynamics and 2D turbulence |
| ♦ 26-30 October 2010 | PIV Delft |
| ♦ 25-29 January 2010 | CFD 1 |
| ♦ February 2010 | Granular matter |
| ♦ 12-14 April 2010 | Computational multiphase flow |
| ♦ April 2010 | Experimental techniques in fluid mechanics |
| ♦ Spring 2010 | Cardiovascular in-vitro and ex-vitro experimental techniques |
| ♦ 11-15 October 2010 | Particle technology |

21 - 24 September 2009

Geophysical fluid dynamics and 2D turbulence

Prof.dr.ir. GJF van Heijst

Place : TUE

This course will concentrate on fundamental aspects of rotating and stratified flows, aiming at a better insight in the dynamics of large-scale flows in seas, oceans and planetary atmospheres. Such insight is also useful for a better understanding of industrial flow configurations in which rotating and/or density effects play a role. Topics that will be discussed include: geostrophic flows, conservation of potential vorticity, Ekman boundary layers, spin-up phenomena, wind-driven ocean circulation, waves in rotating and stratified media, density currents, barotropic and baroclinic instability, sediment transport and bottom morphology, aspects of two-dimensional turbulence and the dynamics of coherent vortex structures. The course includes a number of laboratory and computer sessions, in which the participants can study aspects of the theoretical material presented and discussed during the lectures. Confirmed lecturers : Prof. Herman Clercx (TU/e), Prof. GertJan van Heijst (TU/e), Prof. Hennie Kelder (KNMI & TU/e), Prof. Pieternel Levelt (KNMI & TU/e), Prof. Leo Maas (NIOZ & UU), Prof. Huib de Swart (UU), Dr. Ruben Trieling (TU/e)

Registration for this course: m.j.a.m.rodenburg@tue.nl

For more information contact

GJF van Heijst | 040 247 2722 | g.j.f.v.heijst@tue.nl

26 - 30 October 2009

PIV Delft

Prof.dr.ir. J Westerweel

Place : TUD

Particle Image Velocimetry has rapidly become the standard method for measuring fluid velocities in both fundamental and applied research. In October 2009, a one-week course will be taught at the Delft University of Technology. NB: this course does not replace the yearly course at DLR. In this course the fundamentals of the technique will be taught, including applications in particular fields: microfluidics, turbulence, multiphase flows and aerodynamics. Next to lectures, there will be a number of practical sessions 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 from the JM Burgerscentrum, who will get priority when registering: due to limitations on the available space in the practical sessions, the maximum number of participants is 25. Others interested (postdocs, faculty, researchers from institutes and industry) are welcome to apply as well, but priority is given to JMBC PhD students. Apart from a basic understanding of fluid mechanics, there is no prerequisite knowledge. Detailed, up-to-date information can be found on the website: www.ahd.tudelft.nl/piv/

Confirmed lecturers: prof. dr. ir. J. Westerweel, prof. dr. F. Scarano, dr. ir. C. Poelma, dr.-ing. R. Lindken; more to follow. Venue: The course is hosted by the Laboratory for Aero & Hydrodynamics, part of the Process & Energy department of the Faculty of Mechanical, Materials and Maritime Engineering (3ME) of the Delft University of Technology.

For more information contact

J Westerweel | 015 278 6887 | j.westerweel@tudelft.nl

25 - 29 January 2010

CFD 1

Prof.dr.ir. AEP Veldman, prof.dr.ir. B Koren, and dr.ir. MI Gerritsma

Place : TUD

The course discusses the basic methods for solving the equations that describe the motion of fluids. It is organized as a series of lectures and computer exercises. The basic model problem is the convection-diffusion equation with dominating convection. A number of spatial discretization methods (non-uniform grids) will be discussed with their pros and cons (upwind/central, lower/higher order, finite-difference/finite-volume). Also the stability and accuracy of time-integration methods is shortly discussed. A next step is to study discontinuous solutions of the Euler equations, with focus on the numerical Riemann problem. Several numerical schemes for calculating shocks and contact-discontinuities will be presented; the concept of non-linear limiters is introduced. Also, the incompressible Navier-Stokes equations are discussed. The positioning of the computational grid is assessed (staggered grids), as well as the treatment of boundary conditions. Emphasis is on the role of the pressure. An application is direct numerical simulation of turbulent flow.

For more information contact

AEP Veldman | 050 363 3988 | veldman@math.rug.nl

February 2010

Granular matter

Prof.dr. D Lohse, prof.dr. S Luding, UT

Place : UT

More information will follow.

For more information contact

D Lohse | 053 489 8076 | d.lohse@tnw.utwente.nl | s.luding@ctw.utwente.nl

12 - 14 April 2010

Computational multiphase flow

“Overview of fundamentals, industrial applications and simulation packages

Coordinator: Prof.dr.ir. RAWM Henkes

Place : TUD

Target audience: PhD students of the JMBC, fluid flow engineers in industry and research institutes, and others interested in the topic

Lecturers: various, incl. Ruud Henkes, Rob Mudde, Hans Kuipers, Luis Portela, Harry Hoeijmakers

Course summary

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.

Day 1: Fundamentals

- Overview of methods, including:
- RANS / LES /DNS
- Euler-Euler (Two-fluid) and Euler-Lagrange (Particle tracking)
- Interface capturing (VOF/Level set) and interface tracking
- Lattice Boltzmann Method
- Best practice guidelines
- Numerical issues: single phase versus multiphase
- Particle transport (bubbles, droplets, solids) in channels and pipelines
- Heat and mass transfer

Day 2 and morning Day 3: Applications

- Fluidized beds
- Gas lift reactors and bubble columns
- Mixing tanks
- Separators
- Pumps (incl. cavitation) and multiphase boosters
- Pipelines
- Evaporators/condensers
- Clouds

Day 3 Afternoon: Industrial simulation packages

We aim at discussing various simulation packages, like CFX/Fluent, TransAT, STAR-CD, OpenFoam, OLGA, LEDA

For more information contact

RAWM Henkes | 020 630 37 83 | r.a.w.m.@shell.com

April 2010

Experimental techniques in fluid mechanics

Dr. M Versluis

Place : UT

The course Experimental Techniques 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 shadow 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 and in micro- and nanofluidics.

For more information contact

M Versluis | 053 489 6824 | m.versluis@utwente.nl

Spring 2010

Cardiovascular in-vitro and ex-vitro experimental techniques

Prof.dr.ir. FN van de Vosse

Place : TUE

More information will follow.

For more information contact

FN van de Vosse | 040 247 4218 | f.n.v.d.vosse@tue.nl

11 - 15 October 2010

Particle technology

Prof.dr. S Luding, Ruud van Ommen, Hans Kuipers

Place : UT

More information will follow.

For more information contact

S Luding | 053 489 4212 | s.luding@ctw.utwente.nl

JMBC PhD courses in cooperation with other organisations

*For further information and registration contact the organizer
of the below mentioned courses*

Because the PIV course and the OSPT course are rather expensive and because many PhD-students want to participate in them, the JMBC cannot reimburse the complete costs for these courses. For JMBC PhD-students the JMBC contributes 500 Euro for the fee and reimburse the travel and hotelcosts. (The remaining costs have to be paid by the group to which the PhD-student belongs. The JMBC will not charge the usual 150 Euro). Other PhD-students and staff members from industries and institutes pay the fees mentioned by the organising secretariats of the PIV- and OSPT course. (The JMBC will not charge the usual 150 or 250 Euro).

22-26 March 2010

PIV DLR Goettingen, Germany

More information will follow via the website of the DLR.

OSPT Courses

For further information and registration about any of these events contact the organizer of the OSPT Courses.

OSPT Secretariat

Gert Banis

University of Twente | Faculty of Chemical Engineering

PO Box 217 | NL 7500 AE Enschede | Tel : 053 489 2886 / 2589 | Fax : 053 489 4738

Email : g.h.banis@utwente.nl | <http://ospt.ct.utwente.nl>

ERCOFTAC Courses

For further information and registration about any of these events contact the organizer of the ERCOFTAC Coordination Centre.

ERCOFTAC Coordination Centre

Dr. Thierry URSENBACHER

STI-LMF (Bat. ME), EPFL | CH - 1015 Lausanne | SWITZERLAND

Tel : +41.21.693.53.05 | Fax : +41.21.693.53.07

E-mail : ercoftac@epfl.ch | www.ercoftac.org

Von Karman Institute Courses

For further information and registration about any of these events contact the organizer of the Von Karman Institute.

Von Karman Institute

Attn. Secretariat

Waterloosesteenweg 72 | 1640 Sint-Genesius-Rode | BELGIUM

Tel : +32 2 359 96 11 | Fax : +32 2 359 96 00

E-mail : secretariat@vki.ac.be | www.vki.ac.be

MSc degree courses

General fluid mechanics

Advanced fluid mechanics I (357001)

The objective of this course is to acquire a firm base in classical fluid mechanics. The emphasis is on analytical solutions and their physical implications. Advanced Fluid Mechanics will serve as an introduction to the basic equations and phenomena needed in CFD, turbulence, acoustics and granular flows. Subjects: Conservation laws, vorticity, potential flow in 2D and 3D, conformal mapping and 2D flow, Zhukovsky airfoils, waves, shallow water equations, flow at low Reynolds number, Stokes and Oseen solutions, Hele-Shaw flow, flow at high Reynolds number, boundary layers, self-similarity, hydrodynamic stability, compressible flow, Laval nozzle, shock waves.

Fore more information contact

Dr. Devaraj van der Meer | 053 489 2387 | d.vandermeer@utwente.nl

Compressible flows

Gasdynamics I (AE4-140)

Prof.dr.ir. PG Bakker, TUD

1. Introduction: notations, definitions, equations of state, entropy, speed of sound, integral- and differential form of governing equations, Euler equations, entropy equation, 'weak' solutions, entropy condition I, moving shocks, (x,t)- diagram, entropy conditions II, III, numerical treatment.
2. One-dimensional unsteady flow, lineared: acoustic waves, d'Alembert's solution, characteristic method, discontinuities, Piston problem, simple waves, Riemann's initial value problem.
3. One-dimensional unsteady flow, non-linear: characteristic equations, Riemann invariants, simple waves, Riemann's initial value problem, Hugoniot- and Poisson curves, iterative solution of Riemann problem, characteristic method, compression wave, wave interaction, analogy with 2D-steady.
4. Burgers equation for simple waves: non-viscous Burgers equation, shock equation, shock formation, entropy conditions, viscous Burgers equation, wave interactions.
5. Traffic waves: definitions, concepts traffic equation, characteristics and discontinuities, traffic light, chain collision

For more information contact

PG Bakker | 015 278 5907 | P.G. Bakker@tudelft.nl

Gasdynamics II (AE4-141)

Prof.dr.ir. PG Bakker, TUD

1. Two-dimensional unsteady flows: flow equations vector form of flow equations, diagonalisation, left- and right eigenvectors, 2D wave propagation, enveloping of waves.
2. Non-viscous steady 2D flow: diagonalisation, characteristic directions, hyperbolicity, 'time-like' and 'space-like', flow aligned co-ordinates, compatibility, characteristic methods, Prandtl-Meyer expansion, nozzle design, transonic nozzle flow.
3. Burgers equation for 2D simple waves: non-viscous Burgers equation, shock formation, biconvex airfoil, asymptotic behaviour of shocks, wave interaction.
4. Qualitative theory of 1D viscous flows, equations governing quasi 1D viscous flows, qualitative theory of 2nd order dynamical systems, qualitative aspects of the solutions of the quasi 1D flow equations, frictional effects, Fanno equation, internal structure of a shock wave.

For more information contact

PG Bakker | 015 278 5907 | P.G. Bakker@tudelft.nl

Aeroacoustics (115440)

Prof.dr.ir. A Hirschberg, UT/TUE

Aeroacoustics is the study of sound production by unsteady flows of gas and liquids. After an introduction of basic acoustical concepts and a short discussion of wave propagation in pipes and resonators the course focuses on Lighthill's theory of sound production by flows. Vortex sound theory will be introduced on the basis of an energy balance. The theory is illustrated by simple applications to the clarinet, thermoacoustic instability, acoustical behaviour of air bubbles in water, whistling phenomena.....etc.

For more information contact

A Hirschberg | 040 247 2163 | A.Hirschberg@tue.nl

Multiphase flow, dispersed media and rheology

Multiphase flow and heat transfer (AP3181D)

Dr.Eng. LM Portela, TUD

The course on multiphase flow covers basic parameters for design and operation of process equipment, interfacial phenomena, waves in two-phase flow, dimensionless numbers for scale-up, flow regime dependent modelling, two-phase pressure gradients and phase hold-ups for separated, slug and bubble gas/liquid pipe flow and flow regime maps for inclined tube flows. It will furthermore provide introductions to dispersed gas/liquid flows in simple and complex geometries and dispersed flows with solid particles. Moreover, it will address the two-phase heat transfer aspects of boiling liquids. The course is concluded with a brief introduction to the course on Computational Multiphase Flows.

For more information contact

LM Portela | 015 278 2842 | l.portela@tudelft.nl

Continuümmechanics

Dr. D van den Ende, UT

The continuum model, kinematics, conservatoin laws, the stress tensor, simple materials, special constitutive eqautions, special types of flow, rheological material functions. This course will not be lectured on specific dates, but on an individual base in the form of self-study, after making an appointment with Dr. D van den Ende.

For more information contact

D van den Ende | 053 489 3105 | h.t.m.vandenende@utwente.nl

Capillarity and Wetting Phenomena

Prof.dr. F Mugele, UT

Capillarity is the study of the interfaces between two immiscible fluids or a fluid and a solid. Topics of this course are surface tension, capillary rise, thin films, wetting and dewetting, electrowetting, capillary waves, surfactants, special interfaces.

Previous knowledge: Physics of Fluids or another introductory course in fluid mechanics (required). Course material: Pierre-Gilles de Gennes, Françoise Brochard-Wyart, David Quéré, Capillarity and Wetting Phenomena, Springer Science and Business Media, New York USA (2003). Examination: exercises during the course, written/oral exam at the end of the course. The course will be given between september and end of november.

For more information contact

F Mugele | 053 489 3094 | f.mugele@utwente.nl

Elementary two-phase flow with heat transfer (4P540)

Dr. CWM van der Geld, TUE

This is an introductory course in two-phase flow. Averaging procedures and correlations to be used in practise to compute f.e. pressure drop and heat transfer with boiling. Distribution parameter to extend simple one-dimensional approximate computations. Forces on particles and bubbles, and trajectory computations. Lagally theorem, lift forces and variational approaches. Basic thermodynamics using the grand canonical to introduce interfaces and surface tension. Excess free energy and demonstration that boiling occurs on nucleation sites or at boundaries first. Classic two-component mass diffusion theory: Stefan, filmmodel of the air layer with condensation. Interaction of heat and mass transfer in the rapid evaporation of drops. Mollier diagram. Dropwise condensation.

For more information contact

CWM van der Geld | 040 247 2923 | c.w.m.v.d.geld@tue.nl

Nanoparticulate Materials

Lecturers : Prof.dr. Andreas Schmidt-Ott

Contents :

- What is special about nanoparticulate and nanophase materials? Basic properties (electrical, optical, magnetic, mechanical, chemical) and size effects
- Synthesis of nanoparticulate and nanophase materials, e.g.in flow reactors
- Characterization of nanoparticulate and nanophase materials, including on-line characterization of particles in gas suspension
- present and future applications of nano-composites including solar cells, fuel cells, hydrogen storage, catalysis, magnetic, optical, structural materials

For more information contact

A Schmidt-Ott | 015 278 3540 | a.schmidt-ott@tudelft.nl

Computational Multiphase Flow (AP3551)

Dr.Eng. LM Portela, TUD

This course consists of 12 weeks, starting in the beginning of September, in which the behaviour and description of flows, whereby one phase is dispersed in another phase, will be discussed. The Euler-Lagrange and Euler- $\sqrt{}$ Euler approaches to dispersed multiphase flows will be discussed. During the course, the students will develop a small CFD code, to which subsequently the various important aspects of dispersed flows will be added. The influence of different interaction forces (drag, lift, added mass, etc.) between the phases and the effects of turbulence will be studied using the CFD $\sqrt{}$ code.

For more information contact

LM Portela | 015 2782842 | L.Portela@tudelft.nl

Transport phenomena in conversion processes and manufacturing (st474)

Prof.dr.ir. HEA van den Akker, TUD

Various aspects of manufacturing and conversion processes will be discussed in the course. The topics are: viscous flows in quasis 1D thin layers, extruders, jets and sprays, entrainment, particle motions, two-phase flow, turbulence, stirred vessels, heat and mass transfer. Applications are found in industrial processes and product manufacturing.

For more information contact

HEA van den Akker | 015 278 5000 | h.e.a.vandenakker@tudelft.nl

Multiphase Reactor Engineering (CH3062)

Dr.ir. JR van Ommen, TUD

This is an elective course for MSc en PhD students, taught in the third quarter of the academic year. The course treats the various types of multiphase reactors, such as packed beds, fluidized beds, and bubble columns. A large part of the course consists of modelling assignments, to be made in teams of two or three persons (3 ECTS).

For more information contact

JR van Ommen | 015 278 2133 | j.r.vanommen@tudelft.nl

Nanofluidics

Prof.dr.ir. F Mugele, Dr. J Eijkel, Dr. S Kooi, UT

Introduction: fundamental aspects, intrinsic length scales & geometry applications.
Solid-liquid interfaces: interactions, specific adsorption/desorption, electrolytes near interfaces

Hydrodynamics at small scales: laminar flow; slip vs. no-slip; mixing at small scales

Three-phase systems: capillary forces, (control of) wetting, superhydrophobicity

Electrokinetic effects: electroosmotic pumping, electroviscous effect

Electrophoresis and separation techniques

Colloids (I): chemistry, stability, interactions

Colloids (II): physical properties, self-assembly

Study material: review articles and course script.

Evaluation: assignments during course; final oral presentation about a specific subject

For more information contact

F Mugele | 053 489 3094 | f.mugele@utwente.nl

Physics of Bubbles (357201)

Dr. Michel Versluis, UT

The Bubbles course consists of 2 parts: 4 lectures on the physics of single bubbles and 2 lectures on the behavior of multiple bubbles and bubble clouds. The course treats the forces on bubbles, the acoustics of bubbles and bubble clouds, microstreaming and jets due to bubble oscillation, cavitation and collapse. Subjects: Bubble formation and stability. Static diffusion. Blake threshold. Bubble dynamics. The mass-spring analogy. Damping mechanisms on bubbles. Forced oscillations. Pressure emitted by an oscillating bubble. Forces on bubbles. Equation of motion. Trapping and manipulation of bubbles. Contrast agent microbubbles. Diagnostic and therapeutic applications. Experimental techniques. Acoustical and optical characterization. Non-linear behavior. Harmonics. Surface modes. Cavitation. Sonoluminescence. Shockwaves. Microstreaming. Recommended book: CAVITATION AND BUBBLE DYNAMICS by Christopher Earls Brennen

For more information contact

M Versluis | 053 489 6824 | m.versluis@utwente.nl

Granular Matter (358003)

Dr. Jacco Snoeijer, UT

Granular matter can be considered as the fourth state of matter: Depending on the situation, granular matter can behave as a solid, a liquid, or a gas, but always has its own peculiar properties. When dry sand is poured, it acts as a fluid. The pile on which it is poured is solid-like, stabilized by forces in between the sand beads. When dry sand is strongly shaken or fluidized through a gas stream, it behaves gas-like. This course gives an introduction to granular matter in its various forms.

For more information contact

Dr. Jacco Snoeijer | 053 489 3085 | j.h.snoeijer@tnw.utwente.nl

Numerical computations and modelling

Elements of computational fluid dynamics A (WI4011)

Dr.ir. D van der Heul, TUD

Topics: The governing equations; finite volume methods; stability theory; singular perturbations; numerical methods for the incompressible Navier-Stokes equations; efficient iterative solution methods. MATLAB software is available at <http://ta.twi.tudelft.nl/users/wesseling>
For more information look at <http://ta.twi.tudelft.nl/users/wesseling/cfdcourse.html>

For more information contact

D van der Heul | 020 511 3113 | d.r.vanderheul@tudelft.nl

Advanced Numerical Methods (WI4212) 6 ECTS

Prof.dr.ir. C Vuik and Dr. J. Ryan TUD

This course is an introduction to hyperbolic partial differential equations and a powerful class of numerical methods for approximating their solution, including both linear problems and nonlinear conservation laws. These equations describe a wide range of wave propagation and transport phenomena arising in nearly every scientific and engineering discipline. Several applications are described in a self-contained manner, along with much of the mathematical theory of hyperbolic problems. High-resolution versions of Godunov's method are developed, in which Riemann problems are solved to determine the local wave structure and limiters are then applied to eliminate numerical oscillations. These methods were originally designed to capture shock waves accurately, but are also useful tools for studying linear wave-propagation problems, particularly in heterogeneous material.

For more information see

http://ta.twi.tudelft.nl/nw/users/vuik/wi4212/wi4212_eng.html

Computational modelling of flow and transport (CTwa4340)

Dr.ir. M Zijlema, TUD

The subjects treated are: Mathematical background of numerical errors and artefacts such as numerical damping, oscillations and instability and how to avoid these phenomena. Accuracy and stability as function of resolution and other numerical parameters. Applications in the field of one-dimensional flow and transport in open channels.

For more information contact

M Zijlema | 015 278 3255 | m.zijlema@tudelft.nl

Computational hydraulics (CTwa5315)

Prof.dr.ir. GS Stelling and Dr. J Pietrzak, TUD

Description: Theory and practice of 2D and 3D nonstationary flow and transport computations.

For more information contact

J Pietrzak | 015 278 5466 | j.d.pietrzak@tudelft.nl

Computational fluid dynamics

Prof.dr. AEP Veldman, RUG

Introduction to numerical methods for simulating viscous flow problems: discretization on nonuniform grids, convection-diffusion equation, incompressible Navier-Stokes equations, free-surface flow, Burgers' equation, simulation of turbulent flow (DNS).

For more information contact

AEP Veldman | 050 363 3988 | veldman@math.rug.nl

Boundary-layer flow

Prof.dr. AEP Veldman, RUG

Physical modelling and numerical simulation of laminar and turbulent boundary layers: boundary-layer equations, integral formulation, turbulence modelling, asymptotic structure, flow separation, strong viscous-inviscid interaction.

For more information contact

AEP Veldman | 050 363 3988 | veldman@math.rug.nl

CFD 1 - Incompressible flows (AE4-151)

Dr.ir. M Gerritsma, TUD

Subjects treated: Introduction to Computational Fluid Dynamics. Classification of partial differential equations and well-posedness. Finite volume methods, finite difference methods, finite element methods, boundary element methods and spectral element methods. For the incompressible Navier-Stokes equations two topics will be treated in depth: the relation between the (hyperbolic) convective terms and the (elliptic/parabolic) diffusive terms, and the role of the pressure in incompressible flows and the ensuing compatibility conditions between velocity and pressure approximation. Examination takes place in the form of an assignment in which the student writes and analyzes an incompressible Navier-Stokes solver. This assignment will be concluded with an oral examination.

For more information contact

M Gerritsma | 015 278 5903 | m.i.gerritsma@tudelft.nl

Numerical aircraft aerodynamics (AE4-152)

Prof.dr.ir. H Bijl, TUD

Subjects treated: upwind discretization methods for hyperbolic systems of conservation laws; (approximate Riemann solvers, flux limiters, multidimensional upwinding); multigrid-solution methods (nested iteration, non-linear multigrid, damped direction-dependent multigrid for hypersonic flow computations); conditioning of flow equations for low Mach numbers; local grid adaptation; sparse-grid solution methods; level-set methods for two-fluid flows; software (data and program structures, testing).

For more information contact

H Bijl | 015 278 5373 | h.bijl@tudelft.nl

Advanced numerical techniques for fluid flow and structural engineering (AE4-153)

Prof.dr.ir. H Bijl, TUD

Subjects treated and lecturers: partitioned methods for fluid-structure interactions (dr.ir. H. Bijl), conservative methods for two-fluid flows (dr.ir. E.H. van Brummelen), least-squares spectral element methods (dr.ir. M.I. Gerritsma), discretisation on moving domains and fluid-structure coupling (dr. S.J. Hulshoff) non-conservative methods for two-fluid flows (prof.dr.ir. B. Koren) multigrid algorithms (dr.ir. C.W. Oosterlee), large-eddy simulation (dr.ir. M.J.B.M. Pourquie).

For more information contact

H Bijl | 015 278 5373 | h.bijl@tudelft.nl

Application of the Finite Element Method to heat and flow problems

Dr.ir. CCM Rindt, TUE

In this course the general method to construct a numerical solution of a second order partial differential equation with the Finite Element Method (FEM) is elucidated. Practical aspects like automation, quadrature rules and accuracy of the numerical solution are also highlighted. More specifically, the FEM-method is applied to the solution of incompressible flows (Navier-Stokes equations) and thermally driven flows (Boussinesq approach). Besides, several solution methods of the Navier-Stokes equations are presented like the penalty function approach and projection schemes. Finally, some numerical aspects are shown for time-dependent problems.

Beside the oral courses, there is also the possibility to practice on some classical fluid dynamic problems like the flow over a backward facing step and the flow around a cylinder.

For more information contact

CCM Rindt | 040 247 2978 | c.c.m.rindt@tue.nl

Modelling of Physical Phenomena (4P560)

Dr.ir. JGM Kuerten, TUE

The subject is the modelling of physical phenomena, i.e. the steps necessary to translate a physical problem into a mathematical model and its solution. For many problems in fluid dynamics the mathematical model is a partial differential equation. In the lecture series a number of problems from thermal and fluid mechanics will be studied in this way. Moreover, attention will be paid to analytical and numerical solution methods. Examples which will be treated are: waves in shallow water, heat flow in a bar and air flow around the wing of an airplane.

For more information contact

JGM Kuerten | 040 247 2362 | j.g.m.kuerten@tue.nl

Advanced Programming in Engineering (1158500 - 5.0 EC)

Prof.dr. S Luding, UT

2-3^e quarter 2010. One goal of the lecture is to teach the students the basics of various algorithms and methods used everyday in mechanical engineering, civil engineering, and physics. This will go deep into the basics, involving Advanced Computational Programming and Algorithms. The goal is not using commercial software packages or functions from, for example, Matlab, but to understand the Methods "from the inside".

There will be classroom-lectures to teach basics and theory as well as practical exercises where the learned knowledge will be implemented on the computer.

Several examples will be treated (we would like to receive ideas of examples which relate this lecture to other courses where there is not time to go that deep into the programming) which build upon other lectures (fill in examples or specific courses here).

Unique about this lecture is that some of these examples will be treated by different methods in parallel (for example diffusion can be dealt with by finite differences, finite elements, or stochastic methods). Dependent on the number of participants, this will be either done by split groups, or sequentially so that the students get familiar with the strengths and weaknesses of various numerical methods and approaches.

Required: Basic Programming Skills (!) and Solid Math, Physics, Engineering, Informatics background

For more information contact

S Luding | 053 489 4212 | s.luding@ctw.utwente.nl

Theory of chaos and dynamical systems

Applied Analytical Methods (150950)

Prof.dr. E van Groesen, UT

The goals of the course are 1. to learn to recognise variational structures of various kinds in many problems from the physical and technical sciences, and 2. to learn the mathematical methodology and techniques to exploit these structures (in equations and solutions) for a detailed investigation. Students learn how many problems are described by some variational principle (the principle of minimal potential energy, the action principle for dynamical systems), and that dissipative or conservative properties can be recognised by investigating specific functionals. Special solutions, the physical 'coherent structures' such as solitary waves (solitons) in fluid dynamics or electromagnetism, can then be characterized and obtained in a variational way. The mathematical methods include the calculus of variations, classical mechanics, dynamical system theory and eigenvalue problems. These methods are introduced and extended to infinite dimensional systems (described by partial differential equations). Most applications will be from fluid dynamics (surface waves) and optics.

Topics:

1. Unconstrained variational problems: Theory of first and second variation, natural boundary conditions; variational structures in nature and dynamics: principle of minimal energy, Lagrangian and Hamiltonian systems.
2. Constrained variational problems: Lagrange's multiplier rule; Linear Eigenvalue. Problems: Rayleigh quotient, comparison theorems.
3. Variational restrictions: Approximations in solutions or model equations by restriction of the functional to suitable subsets. Introduction to numerical methods like FEM and variational consistent modelling.

Appendices: A. Fluid Dynamics | B. Optics | C. Solitons and wave groups

For more information contact

E van Groesen | 053 489 3413 | e.w.c.vangroesen@utwente.nl

Advanced Modelling in Science (150910)

For the content see : www.mastermath.nl/courses/00005/00004.

For more information contact

E van Groesen | 053 489 3413 | e.w.c.vangroesen@utwente.nl

Chaos (3T220)

Prof.dr.ir. W van de Water, TUE

Chaos is the disordered behavior of nonlinear systems with just a few degrees of freedom: very simple but nonlinear systems. We will see why the route to chaos is often universal. This universality can be expressed in terms of a renormalisation theory, which expresses the invariance of the dynamics under a change of scale. We will discuss the Feigenbaum--Cvitanovic renormalisation equation for the route to chaos through period doublings. Next, we will walk the road to chaos along the golden mean in the case of competition of nonlinear oscillators. The emphasis will be on systems with dissipation, but we will see a simple geometric description of the route to chaos in Hamiltonian systems. A theory of scales is beautifully illustrated by the concept of fractals. It is possible to give a thermodynamic description of these strange things. We will discuss practical applications to control nonlinear systems and to influence chaos. The course offers fundamental insight in this modern subject, but the emphasis is on practical application in simple systems. Interactive computer simulations of real systems offer a vivid illustration of the more theoretical material. The course also offers a unique exposure to modern literature on chaos: During one half of the course the basic concepts are introduced, and in the other half each participant presents an article on chaos which appeared in the past year in Physical Review Letters. Of course, adequate coaching is offered.

For more information contact

W van de Water | 040 247 3443 | w.v.d.water@tue.nl

Combustion

Chemistry and transport in energy conversion processes (4S580)

Prof.dr. LPH de Goey, TUE

More than 80% of our energy is generated by combustion of fossil and future (bio)-fuels in equipment like engines, gas turbines, furnaces in the (process)-industry and burners in domestic and industrial appliances. The physical and chemical processes, which describe the combustion phenomena in the different mentioned appliances, will be treated. After a global description of the different combustion methods and their application, the global balances and the elementary processes in reacting flows will be presented. Ideal reactors, like the perfectly stirred reactor and the homogeneous reactor, form the starting point of the treatment of ignition phenomena. Flames and flame fronts will be discussed afterwards. The movement of premixed flame fronts on Bunsen burners, surface burners and in Otto engines will be analyzed. Non-premixed flame fronts, like on burners, furnaces and Diesel-engines, will be treated afterwards and the course will be finished with an analysis of the influence of combustion processes on the environment. Software for the analysis of simple combustion processes, like perfectly stirred reactors, plug-flow reactors and flat flame fronts will be used in the guided self-study.

Fore more information contact

LPH de Goey | 040 247 2938 or 2140 | l.p.h.d.Goey@tue.nl

Gasturbines (4P700)

Dr.ir. HC de Lange, TUE

The gasturbine is one of the most often used machines in the production of mechanical power. In this course a number of application areas (aero engines, turbochargers, industrial applications) will be discussed. Using the book by Cohen et al. the thermo- and fluid dynamics of turbomachines is studied. First, different systems (using intercooling, regeneration, etc.) are compared using simple thermodynamical theory. They show the applicability and efficiency of different processes. Second, the working principles of both radial and axial compressors are explained based on compressible flow equations (both one- and more dimensional). Using aerodynamical arguments the working of a combined compressor/turbine is discussed, both in the design-point as well as at offdesign conditions. Besides the stationary flow considerations, a number of dynamical aspects (acceleration, stall, surge, etc.) will be discussed.

Books: H.I.H. Saravanamuttoo, G.F.C. Rogers and H. Cohen, 'Gasturbine theory', 2001.

Fore more information contact

HC de Lange | 040 247 2129 | h.c.d.lange@tue.nl

Turbulent reacting flows (AP3561)

Prof.dr. DJEM Roekaerts, TUD

Period: September-December 2010.

Course Material: Thierry Poinsot and Denis Veynante "Theoretical and numerical combustion", Edwards, 2005, ISBN: 1-930217-10-2. This text describes basic techniques and recent progress in the field of numerical combustion. Lecture notes or articles on additional topics. Models for interaction between turbulent flow and chemical reaction are treated. The main question addressed is by which method or model the mean properties of the flow can be obtained without having to solve the transport equations in full detail. Such methods are useful in the design of industrial combustion chambers, chemical reactors and in the description of reactions in the atmosphere. In the first part, basic aspects are developed (transport equations, reaction kinetics, non-dimensional numbers and regime diagrams, fundamentals of a statistical description, laminar flames). In the second part a more extensive introduction to turbulent combustion is presented. Methods for handling the closure problems arising in averaged or filtered transport equations are described and evaluated (RANS, LES, flamelet model, probability density function method). Simple application exercises are made. Depending on the specific interest of the student, additional topics can be added.

For more information contact

DJEM Roekaerts | 015 278 2470 | d.j.e.m.roekaerts@tudelft.nl

Non-linear differential equations (WI4019TU)

Dr.ir. WT van Horssen, TUD

1st semester, second quarter.

F. Verhulst, Nonlinear Differential Equations and Dynamical Systems, 2nd edition, Springer-Verlag, 1996.

Take home exam and oral exam.

Introductory course on Differential Equations e.g. Boyce and DiPrima, Chapters 2-7, 9.

Existence and uniqueness of initial value problems, Gronwall's lemma, Autonomous systems, Critical points, Periodic solutions, Stability theory, Linear systems and Floquet theory, Perturbation theory and asymptotic methods, Poincare-Lindstedt method, Averaging method, Multiple time-scales method, Elementary bifurcations.

For more information contact

WT van Horssen | 015 278 3524 | w.t.vanhorssen@tudelft.nl

Advanced combustion diagnostics using laser techniques (4P620)

Dr. NJ Dam, TUE

The main goal of this course is to achieve knowledge and understanding of the use and applications of various laser-optical techniques for diagnostics of high temperature systems in general, and various combustion systems in specific. Of specific interest is to develop insight into different non-intrusive techniques for species concentration measurements, temperature measurements and measurements of particle characterization in high temperature environments. After a brief overview of laser-optical diagnostics techniques and an introduction to basic molecular spectroscopy and optical-laser instrumentation, the course involves the following subjects:

- Diagnostics of soot characterization by scattering/extinction and Laser-Induced Incandescence (LII);
- Theory and fundamentals of Laser-Induced Fluorescence followed by thermometry and imaging applications;
- Rayleigh and Raman scattering for species concentration measurements and thermometry;
- Coherent anti-Stokes Raman Scattering (CARS) basic theory and thermometry applications;
- Applications of Thermographic phosphors for surface, droplet and gas phase thermometry;
- Non-linear optical techniques, e.g. Stimulated emission, Degenerate Four-Wave Mixing and Polarization spectroscopy for minor species detection;
- Finally an overview of emerging techniques, e.g. Ballistic imaging for diagnostics in dense sprays and picosecond LIDAR measurements for spatially resolved measurements in environments with limited optical access.

For more information contact

NJ Dam | 040 247 9111 | n.j.dam@tue.nl

Engines: Modeling and analysis

In this lecture series the student will apply the first law of thermodynamics to the general systems of reacting mixtures. Using temperature dependent thermodynamic properties (NASA polynomials) a cycle simulation model and an experimental analysis script will be derived.

Modeling: a matlab based computer program to simulate a real engine cycle using a modeled combustion progress (Wiebe-like). The oral lectures are short and only meant to give a concise introduction to the problem. A systematic approach is used to increase the complexity in a gradual way through the organization of the lectures series. Emphasis is not on numerics but on physics.

Analysis: experiments performed on the University Racing team engine testbench (600 cc Suzuki) will be analyzed. Using the same first law analysis as above, the Sankey diagram will be determined and engine parameters like thermal efficiency, BMEP etc, computed. The course is mainly in hands-on exercise and a notebook and Matlab are required. Final term: written report .

For more information contact

B Somers | 040 247 2107 | l.m.t.somers@tue.nl

Fuels and Lubes (4N850)

Dr.ir. CCM Luijten, ir. HJ van Leeuwen, ir. MD Boot

Geopolitical, environmental and societal factors are forcing the automotive industry to develop more efficient and cleaner burning engines. In current engine design processes, fuels and lubricants are regarded as "facts of life". However, future requirements in terms of fuel efficiency and emissions, may be easier to meet when the chemical structure of fuels and lubricants is adjusted in a proper way. Therefore, a lot of research is going on worldwide to characterize alternative fuels such as biofuels, synthetic fuels, oxygenated fuels, dual fuelling strategies, and so on. The same holds for lubricants research. In the course, starting from knowledge of the molecular (hydrocarbon) structure of fuels and lubricants available today (plus the likely options for the future), the student will learn to compute or estimate the relevant physical (density, saturation pressure, viscosity) and chemical properties (e.g. auto-ignition, heating value, adiabatic flame temperature). Essential engine processes such as lubrication, spray formation, evaporation, and formation of emissions (such as NO_x and soot) in an engine will be discussed with emphasis on which physical, chemical and tribological properties of fuels and lubricants play a role. The ultimate goal is the 'reverse engineering' step: given the requirements to the engine, the student should be able to 'design' the proper fuel and lubricant for a given application. Near the end of the course trends in fuels and lubricants are discussed, and further illustrated by a couple of guest lectures by leading experts.

For more information contact

CCM Luijten | 040 247 5347 | c.c.m.luijten@tue.nl

Powertrain components (4AT00)

Dr.ir. CCM Luijten, dr.ir. LMT Somers, dr.ir. T Hofman

This introductory course on automotive power trains (including engine and transmission), covers the basic technology behind automotive vehicle propulsion. In the introductory lecture, basic road load forces will be discussed in order to derive the amount of torque and power a vehicle power train should deliver. Next, the principles of 4-stroke Internal Combustion Engine are discussed (components, kinematics and operating characteristics). Some elements of ICE operation (a.o. gas exchange, cycles, thermo chemistry and fuels, fuel consumption and emissions) are discussed in more depth in order to enable students to make quantitative computations. The course continues by treating the history and basic principles of the automotive drive train and its components. The aim of this part is to obtain a broad (and in some aspects deep) insight in components, systems and system designing of vehicle drive trains. Some basic powertrain modeling techniques will be treated, followed by the somewhat more detailed analysis of the Toyota Prius powertrain. This example and others will be used to explain the challenges that powertrain designers are facing nowadays. The course consists of 18 hours of lectures, with additional practical exercises in the laboratories of Automotive Engineering Science (2x half a day).

For more information contact

CCM Luijten | 040 247 5347 | c.c.m.luijten@tue.nl

Turbulence

Turbulence in hydraulics (CT5312)

Dr.ir. WSJ Uijttewaal TUD

This course is an introduction to turbulence with applications in hydraulics. The subjects treated are: statistical description of turbulence, Reynolds equations, energy equation, turbulent boundary layers, free shear flows, turbulence models, dispersion and diffusion, experimental techniques.

For more information contact

WSJ Uijttewaal | 015 278 1371 | w.s.j.ujttewaal@tudelft.nl

Turbulence A (wb1424A)

Prof.dr.ir. B.J. Boersma TUD

In this lecture an introduction is given to the theory of turbulent flow. The topics treated are: stability theory, Burgers equation phenomenology, averaging, Reynolds-decomposition, K-theory, closure models, logarithmic velocity profile, equations for turbulence energy and vorticity, dissipation equation, k-epsilon equation, correlation and spectra, turbulent diffusion

For more information contact

BJ Boersma | 015 278 7979 | b.j.boersma@tudelft.nl

Turbulence B (wb1424b)

Prof.dr.ir. B.J. Boersma, TUD

This is a special topic lecture in which using a number of research articles modern topics of turbulence research are studied. Participants contribute by presentation and discussions. Examples of topics are: the turbulent boundary layer, homogeneous turbulence, concentration fluctuations etc.

For more information contact

BJ Boersma | 015 278 7979 | b.j.boersma@tudelft.nl

Advanced Physical Transport Phenomena (TN375-3)

Dr.ir. S Kenjeres, TUD

The covered subjects are: heat diffusion: stationary and instationary transport, moving boundary problems; mathematical methods: separation of variables, Laplace transformation, integral methods; momentum transport: potential flow, creeping flow, boundary layer flow; turbulence modelling; numerical methods in Computational Fluid Dynamics.

For more information contact

S Kenjeres | 015 278 3649 | s.kenjeres@tudelft.nl

Turbulence (358001)

Prof.dr. Detlef Lohse, UT

Subjects: Navier-Stokes equations, hydrodynamic instabilities, routes to chaos, transition to turbulence, Rayleigh-Benard convection, Boussinesq equation, fully developed turbulence, Kolmogorov, intermittency, phenomenological models for intermittency, cascade models, Keps model, boundary layer theory, turbulent diffusion.

Fore more information contact

D Lohse | 053 489 8076 | d.lohse@utwente.nl

Waves and free-surface flows

Unsteady flow in conduits (CT3310)

Ir. RJ Labeur, TUD

Subjects to be treated are: categories of long waves in open channels: translatory waves, tides, harbour oscillations, floodwaves in rivers; basic equations for long waves in open channels and in closed conduits; translatory waves of low and finite height; method of characteristics; harmonic method for sinusoidal wave propagation with linearised damping; flood waves in rivers; advection, diffusion and dispersion of solutes and suspended matter in free-surface flows.

For more information contact

RJ Labeur | 015 278 5069 | r.j.labeur@tudelft.nl

Short waves (CT4320)

Dr.ir. LH Holthuijsen, TUD

Subjects to be treated are: basic equations for short waves, theory for sinusoidal waves, undeformed propagation, propagation in water with variable depth and in the vicinity of breakwaters, behaviour of waves in coastal areas, wave loads on structures, statistical properties of random waves.

For more information contact

LH Holthuijsen | 015 278 4803 | l.h.holthuijsen@tudelft.nl

Stratified flows (CT5302)

Dr. JD Pietrzak, TUD

Flows influenced or caused by differences in density. Basic equations. The two-layer model. Internal and external long waves. Steady-state two-layer flows. Internal hydraulic jumps and gravity currents. Stability, turbulence and mixing. Salt intrusion in estuaries.

For more information contact

JD Pietrzak | 015 278 5466 | j.d.pietrzak@tudelft.nl

Wind waves (CT5316)

Dr.ir. LH Holthuijsen, TUD

Subjects to be treated are: concepts from the theory of stochastic processes, energy-density spectrum, wind waves considered as stochastic processes in space and time, statistical properties, development and propagation of wind waves, wave climate, spectral calculations and responses.

For more information contact

LH Holthuijsen | 015 278 4803 | l.h.holthuijsen@tudelft.nl

Physical Oceanography (CT5317)

Dr. JD Pietrzak, TUD

The Free surface flow course will deal with the following topics: The physics of free surface waves; Linear wave theory, non-linear waves; Short waves, shallow water waves; Numerical methods for various wave models, e.g. Delft3D and SWAN.

For more information contact

JD Pietrzak | 015 278 9455 | j.d.pietrzak@tudelft.nl

River Systems (540021)

Dr. F Huthoff, drs. JJ Warmink, UT

Introductory into the physical processes in natural river systems. Phenomena in natural river system are explained and described in a qualitative way. The following processes are discussed: meandering, shifting riverbeds, bank erosion, stream roughness and sort processes. This course is a prerequisite for Shallow water flow (540041) and Transport processes and morphology (540042).

For more information contact

F Huthoff | 053 489 3911 | f.huthoff@utwente.nl

Shallow water flow (540041)

Dr.ir. JS Ribberink, UT

In this course steady and unsteady shallow water flows are discussed for rivers, with topics such as backwater curves, flood waves, tidal flows. Dynamic behavior and physical-mathematical modeling will be discussed particularly for 1-D flows. Case studies from river management will be used to illustrate flow phenomena and the influence of human interventions. Application of 1-d models will be exercised in a computer exercise.

For more information contact

JS Ribberink | 053 4892767 | j.s.ribberink@utwente.nl

Transport processes and morphology (540042)

Dr.ir. JS Ribberink, UT

This course involves i) transport processes of dissolved substances and sediment (advection, diffusion, exchange with bottom), (ii) morphologic processes, as occur in surface water systems. Understanding and modelling spreading of suspended sediment, bed load of sand or gravel, erosion or sedimentation on the bottom (morphology). Insight in characteristics and dynamic behaviour, particularly for river systems. The basis is formed by 1-D physical-mathematical models.

Transport processes and morphology, either or not affected by human interventions, will be analysed for practical examples. In a computer exercise, a 1-D (numerical) model will be applied to a particular morphologic river problem.

For more information contact

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Marine Systems (540024)

Dr. TAGP van Dijk, UT & Deltares

Introduction to physical processes in a marine environment. The physical processes are described and explained in a qualitative way. The following processes are discussed: behaviour of waves, tide, sediment transport, beach morphology as well as the main characteristics of estuaries, river delta's, continental shelves and shallow seas. The course Marine Systems provides knowledge for Marine Dynamics II (540081) and Seminar Morphology (540082)..

For more information contact

TAGP van Dijk | 053 489 4705 | t.a.g.p.vandijk@utwente.nl

Marine Dynamics (540080)

FM van der Meer, UT

The first part of this course (Marine Processes) focuses on a quantitative description of marine processes, which were considered in a more qualitatively sense in the course Marine Systems (540024). The second part of this course (Coastal & Offshore Engineering) focuses on engineering applications in marine environment, such as coastal protection, harbours, offshore wind farms, etc.

For more information contact

FM van der Meer | 053 489 5608 | f.m.vandermeer@ctw.utwente.nl

Seminar Morphology (540082)

Prof.dr. SJMH Hulscher, UT

This course covers four topics related to morphology of rivers, estuary, coasts and seas in which physical processes play an important role. Understanding and prediction of morphological developments are important aspects of water management. Practical examples are the deepening of the Western Scheldt, maintaining the coast line, and the protection of pipe lines in a dynamic sea bed. Scientific papers will be used to study these topics. Students present and discuss these papers based on a number of questions. In addition, each student has to write a report on a specific topic and present a poster on this topic to fellow students and department members.

For more information contact

SJMH Hulscher | 053 489 4256 | s.j.m.h.hulscher@utwente.nl

Micro-scale fluid mechanics

Microfluidics (WB1429)

Dr. R. Lindken TUD

This course is an introduction to fluid mechanics at small scales. The subjects treated are: Scaling laws, Navier-Stokes equations for micro-scale gas and liquid flows, for electro-osmotic flow, electrophoresis, dielectrophoresis, dispersion and diffusion, capillary effects, experimental techniques, applications in flow control, flow sensors, valves, pumps, mixers, filters, separators, heaters and life science applications.

For more information contact

R Lindken | 015 278 9911 | r.h.lindken@tudelft.nl

Experimental techniques in fluid mechanics

Experimental techniques in physics of fluids (358002)

Dr. Chao Sun, UT

In this course we will discuss the most common experimental techniques that are used in fluid dynamics. Specific advantages, but most of all the limitations of certain techniques will be presented. The course is comprised of lectures, informative lab tours, "hands-on" lab tours, short presentations of experts in the course field and partial assignments, based on review articles from specialist literature. The course is completed by performing an experimental assignment, and a written and oral presentation of the results

Fore more information contact

Dr. Chao Sun | 053 489 2568 | c.sun@tnw.utwente.nl



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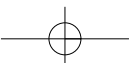
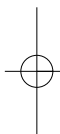
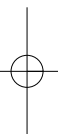
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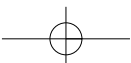
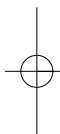
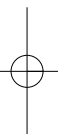
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