

- ☐ INTRODUCTION TO MEASUREMENT TECHNIQUES  
OCTOBER 7-11, 2013
- ☐ ADVANCED POST-PROCESSING OF EXPERIMENTAL AND NUMERICAL DATA  
NOVEMBER 4-7, 2013
- ☐ FLUID MECHANICS AND CHEMISTRY FOR SAFETY ISSUES IN HLM NUCLEAR REACTORS  
NOVEMBER 25-27, 2013
- ☐ 37<sup>TH</sup> ADVANCED VKI CFD LECTURE SERIES: RECENT DEVELOPMENTS IN HIGHER ORDER METHODS AND INDUSTRIAL APPLICATION IN AERONAUTICS  
DECEMBER 9-12, 2013
- ☒ INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS  
JANUARY 20-24, 2014
- ☐ HYPERSONIC FLIGHT TESTING (VKI-STO-AVT-234)  
MARCH 24-28, 2014
- ☐ INTRODUCTION TO OPTIMIZATION AND MULTIDISCIPLINARY DESIGN IN AERONAUTICS AND TURBOMACHINERY  
APRIL 7-11, 2014
- ☐ LARGE EDDY SIMULATION  
MAY 5-9, 2014
- ☐ SPECTROSCOPY AND SPECTROSCOPIC MEASUREMENT TECHNIQUES FOR AEROSPACE FLOWS  
MAY 13-16, 2014
- ☐ UAV & SMALL AIRCRAFT DESIGN  
MAY 20-22, 2014
- ☐ UNCERTAINTY QUANTIFICATION IN COMPUTATIONAL FLUID DYNAMICS (VKI-STO-AVT-235) AT STANFORD, CALIFORNIA  
MAY 26-27, 2014
- ☐ PROGRESS IN FLOW INSTABILITY ANALYSIS AND LAMINAR-TURBULENT TRANSITION MODELING  
JUNE 2-6, 2014
- ☐ PHYSICS OF SLOSHING LIQUIDS: EXPERIMENTS AND MODELING  
SEPTEMBER 1-5, 2014
- ☐ UNCERTAINTY QUANTIFICATION IN COMPUTATIONAL FLUID DYNAMICS ( VKI-STO-AVT-235)  
SEPTEMBER 22-26, 2014

## VON KARMAN INSTITUTE

VKI is a non-profit international educational and scientific organisation, hosting three departments (aeronautics and aerospace, environmental and applied fluid dynamics, and turbomachinery & propulsion).

It provides post-graduate education in fluid dynamics (research master in fluid dynamics, former "VKI Diploma Course", doctoral program, short training program and lecture series) and encourages "training in research through research". The von Karman Institute undertakes and promotes research in the field of fluid dynamics.

It possesses about fifty different wind tunnels, turbomachinery and other specialized test facilities, some of which are unique or the largest in the world. Extensive research on experimental, computational and theoretical aspects of gas and liquid flows is carried out at the VKI under the direction of the faculty and research engineers, sponsored mainly by governmental and international agencies as well as industries.

The von Karman Institute organizes each year about 12 one-week Lecture Series on specialized topics in the field of aerodynamics, fluid mechanics and heat transfer with application to aeronautics, space, turbomachinery, the environment and industrial fluid dynamics. These courses have gained over the years world wide recognition for their high quality, which is the result of a careful choice of subjects of current interest and lecturers known for their excellency and willing to co-operate in building up well-structured courses.

von Karman Institute for Fluid Dynamics  
Waterloosesteenweg 72  
1640 Sint-Genesius-Rode, Belgium

Phone: +32(0)2 359 96 04, Fax: +32(0)2 359 96 00  
E-mail: [secretariat@vki.ac.be](mailto:secretariat@vki.ac.be), Website:  
<https://www.vki.ac.be>, TVA BE 0407 185 709



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# INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS

January 20-24, 2014



VON KARMAN INSTITUTE  
FOR FLUID DYNAMICS



## INTRODUCTION

The objective of this course is to provide an elementary tutorial presentation on computational fluid dynamics (CFD), emphasizing the fundamentals and surveying a variety of solution techniques whose applications range from low speed incompressible flow to hypersonic flow. The course is aimed at persons who have had little or no experience in this field, both recent graduates as well as professional engineers, and will provide: -an insight into the philosophy and power of CFD; - an understanding of the mathematical nature of the fluid dynamics equations; - a familiarity with various solution techniques.

At the conclusion of the course, an attendee will be well prepared to understand the literature in this field, to follow more sophisticated state-of-the-art lecture series, and to begin the application of CFD to his or her special areas of concern. While the techniques to be discussed will be applicable to all fields of fluid dynamics, the lecturers and the majority of examples presented will carry a strong flavor of aeronautics.

The Director of this lecture series is Professor G. Degrez of the von Karman Institute.

## TIMETABLE

### MONDAY 20 January 2014

- 08:45 Registration
- 09:15 Welcome, introductory remarks
- 09:45 Basic philosophy of CFD  
*Prof. J.D. Anderson, Jr., University of Maryland, USA*
- 11:00 Forms of the governing equations particularly suited for CFD: non-conservative, conservative, flux vectors  
*Prof. J.D. Anderson, Jr.*
- 14:00 Mathematical properties of the fluid dynamic equations : influence on appropriate numerical techniques; stability considerations  
*Prof. J.D. Anderson, Jr.*
- 15:45 Mathematical properties of the fluid dynamic equations (continued)  
*Prof. J.D. Anderson, Jr.*
- 17:00 Reception

### TUESDAY 21 January 2014

- 09:00 Discretisation of partial differential equations : finite differences  
*Prof. J.D. Anderson, Jr.*
- 11:00 Discretisation of partial differential equations (cont'd)  
*Prof. J.D. Anderson, Jr.*
- 14:00 Transformation and grids  
*Prof. J.D. Anderson, Jr.*
- 15:45 Explicit methods for inviscid and viscous compressible flows  
*Prof. J.D. Anderson, Jr.*

### WEDNESDAY 22 January 2014

- 09:00 Explicit methods (continued)  
*Prof. J.D. Anderson, Jr.*

- 11:00 Implicit time dependent methods for inviscid and viscous compressible flows  
*Prof. G. Degrez, von Karman Institute, Belgium*
- 14:00 Implicit methods (continued)  
*Prof. G. Degrez*
- 15:45 Implicit methods (continued)  
*Prof. G. Degrez*

### THURSDAY 23 January 2014

- 09:00 Implicit methods (continued)  
*Prof. G. Degrez*
- 11:00 Finite volume methods  
*Prof. E. Dick, University of Ghent, Belgium*
- 14:00 Finite element methods  
*Prof. E. Dick*
- 15:45 Finite element methods (continued)  
*Prof. E. Dick*

### FRIDAY 24 January 2014

- 09:00 Aspects of CFD computations with commercial packages  
*Prof. J. Vierendeels, University of Ghent, Belgium*
- 11:00 A brief introduction to turbulence models  
*Dr.-Ing. F. Menter, Ansys, Germany*
- 13:45 A brief introduction to turbulence models (continued)  
*Dr.-Ing. F. Menter*
- 15:00 Adjourn

Lunch will be taken from 12h30 to 13h45. Coffee breaks are scheduled each morning and afternoon. The afternoon sessions will normally finish at about 17h00.



VON KARMAN INSTITUTE FOR  
FLUID DYNAMICS

## ONLINE REGISTRATION AVAILABLE

<https://www.vki.ac.be/registration>

It is highly recommended that the registration is sent at the latest 15 days before the beginning of the course. A letter of acceptance and additional information will be sent on receipt of the application form.

## COURSE FEE (5 days)

VAT included	Type 1 (€)	Type 2 (€)	Type 3 (€)
Normal Fee	1350	1760	1920
PhD Candidate Fee**	675	675	960
Undergraduate Student Fee**	300	300	400

**Type 1:** Permanents residents of NATO countries funding VKI: Belgium, Czech Rep., France, Germany, Hungary, Iceland, Italy, Luxemburg, Norway, Portugal, Spain and Turkey

**Type2:** Permanents residents of NATO countries not funding VKI or NATO partners countries

**Type 3:** Permanents residents of non -NATO countries

**\*\* The request to be considered for an award must accompany the application to attend the Lecture Series, and the applicant must provide a recommendation letter from his or her professor; if not done so, the request will not be taken into consideration. All possible alternative sources of funding should be investigated before aid is requested under this scheme, so that those most in need will benefit.**

## REDUCTION

**-50% for the 3<sup>rd</sup> & 4<sup>th</sup>... participant in the same company.**

The fee includes printed notes, lunches, beverages, and administrative costs.