



# LECTURE SERIES

## PROGRAMME

2008 - 2009

Lecture Series Secretary  
von Karman Institute for Fluid Dynamics  
72 chaussée de Waterloo  
B - 1640 Rhode-Saint-Genèse

VON KARMAN INSTITUTE FOR FLUID DYNAMICS



(Please correct your address if necessary)

## GENERAL LECTURE SERIES INFORMATION

- **Printed notes** will be distributed to all participants at registration on the first day.
- **Living accommodation** is not available in the Institute's grounds. Information on **hotels** in Brussels will be sent with the detailed announcements.
- Bus transportation from Brussels to the Institute and return will be provided and is included in the fee.
- Lectures will be given in **English**.
- **Hours** are normally from 09.00 to 17.00.
- **Lunch** is available at the Institute and is also included in the fee.

### FEES

The fee for the lecture series is 1.300 euro, applicable to citizens of NATO countries contributing to the financing of the VKI (Belgium, Czech Republic, France, Germany, Hungary, Iceland, Italy, Luxemburg, Norway, Portugal, Spain and Turkey). For citizens of other NATO countries and of NATO partner countries, the fee is 1.700 euro. For non-NATO citizens the fee is of 1.850 euro. These prices include 21% VAT.

The fee for a four or five day RTO AVT-VKI Lecture Series is of 890 euro for all participants. The fee includes printed notes, transport between VKI and to the recommended hotels, lunches, beverages, and administrative costs.

### FELLOWSHIPS

To encourage greater participation in our Lecture Series programme by university members, the Institute has established a limited number of VKI Lecture Series fellowships for citizens of NATO countries contributing to the financing of the VKI, as well as for citizens of other NATO countries coming from a university in a VKI financing country.

The recipient of such fellowship is entitled to attend the Lecture Series at a reduced fee, which will be of 650 euro (VAT included) for assistants not having a Ph.D. degree and for Ph.D. candidates, or 300 euro (VAT included) for undergraduate students.

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.

## THE VON KARMAN INSTITUTE

Dr. Theodore von Karman, working with the countries of the North Atlantic Treaty Organisation, founded the von Karman Institute in 1956. The staff of the Institute carry out research and provide training in three main areas, viz. aeronautics/aerospace, environmental and applied fluid dynamics, and turbomachinery and propulsion. An array of modern facilities, instrumentation and computational aids, as well as a full complement of technical personnel, provide the backing which is essential for the Institute's programmes. In addition to the Lecture Series, these programmes include a one-year postgraduate course, doctoral research, an advanced research orientation programme and courses for selected undergraduates.

Participants in the above programmes from NATO countries which support the Institute are not assessed a tuition fee. Fellowships are available. Those requiring further information about any of these programmes or with specific suggestions to make regarding special courses are encouraged to write to :

The Director  
von Karman Institute for Fluid Dynamics

## info

**Further details** concerning the content of these courses will be announced on the **VKI web site**:  
<http://www.vki.ac.be> approximately four months in advance of each Lecture Series.

If interested in specific courses, please send an **email** to: [secretariat@vki.ac.be](mailto:secretariat@vki.ac.be) to be registered in our mailing list.

*Please display this announcement so that it can be brought to the attention of as many people as possible*

FOR FURTHER INFORMATION  
von Karman Institute for Fluid Dynamics  
Lecture Series Secretariat  
72 chaussée de Waterloo  
1640 Rhode-Saint-Genèse, Belgium  
Tel : 32 2 359 96 04 - Fax : 32 2 359 96 00  
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website : <http://www.vki.ac.be>

# THE VON KARMAN INSTITUTE FOR FLUID DYNAMICS

offers the following **Lecture Series** during the 2008-2009 academic year. Lectures will be given by active specialists drawn from universities, research establishments and industries from all over the world.

## INTRODUCTION TO MEASUREMENT TECHNIQUES

OCTOBER 6-10, 2008

□ The objective of this course is to provide young engineers with a broad overview of traditional and advanced measurement techniques applicable to fluid dynamics. Each measurement technique and its field of application will be described. Limitations and advantages will be discussed and special attention will be given to the subject of error estimation. A choice of relevant techniques will be demonstrated to groups of five people maximum during lab sessions on Thursday afternoon and Friday in the VKI facilities. This will provide an opportunity to manipulate the available hardware and will allow for discussion of individual problems. This course, prepared and presented by the VKI teaching staff, is based on a long experience with the different techniques for research applications. (see more details in announcement included).

## 35<sup>TH</sup> CFD / ADIGMA COURSE ON VERY HIGH ORDER DICRETIZATION METHODS

OCTOBER 13-17, 2008

□ Schemes with order of accuracy higher than two have become a hot topic in CFD, and the perspective of applying them in industrial aeronautical context is realistic within the next decade. In this course the basics and state of the art of the following methods will be discussed in detail: Discontinuous Galerkin Finite Element methods; Spectral Element and Finite Volume methods; ENO-reconstruction and Residual Based Finite Volume methods; Residual Distribution schemes. Applications are foreseen in the area of compressible aerodynamics and aeroacoustics.

The course is organized in collaboration with the European Union targeted research project ADIGMA, and will bring together a balanced mix of European and American top researchers in the field.

## INTRODUCTION TO CFD

JANUARY 12-16, 2009

□ This course is intended to provide the basic information required to initiate research or applications in most of the important domains of computational fluid dynamics. Participants are expected to have little experience in the field. Topics to be treated will include fundamental mathematical properties of a system of partial differential equations and corresponding boundary conditions, finite difference and finite element techniques, computational methods for different flow regimes: potential, boundary layer, Euler and Navier-Stokes.

The course will be similar to the very successful course of the same title offered since 1985 and will employ many of the same. (See more details in announcement included).

## RECENT ADVANCES IN PARTICLE IMAGE VELOCIMETRY

JANUARY 26-30, 2009

□ Particle Image Velocimetry (PIV) has appeared 25 years ago and since its beginning it has drastically improved in all fields. During that time it has also spread in most fluid dynamic laboratories and it is used in a very large range of applications. This Lecture Series aims at presenting the state-of-the-art of the advances of PIV and also the current work of the teams who are performing new developments. Lectures will be devoted to the development of hardware such as camera and lasers and a large emphasis will be given to processing algorithms and 3D methods such as Tomoscopic PIV. Various PIV techniques such as micro-PIV or large scale PIV should also be discussed. This course should be a good opportunity for researchers and scientists to have a direct contact with the latest progress of the technique and to be able to discuss with the best specialists of the domain.

## MODELING AND COMPUTATION OF NANOPARTICLES IN FLUID FLOWS (RTO-AVT-VKI)

FEBRUARY 9-12, 2009

□ This Lecture Series is especially dedicated to the numerous topics arising when researchers have to predict numerically the behaviour of nanoparticles in a fluid. Beside an isolated nano object, the keyword of nanoparticle has to be understood more generally as including also agglomerate of nano-particles, of nano-tubes and/or related complex structures. As a matter of fact, numerous questions arise when the path of such objects have to be predicted. Already concerning the methods and the tools, what is the best alternative if the relative size of the particle compare to the local molecular mean free path forbids the use of a Navier-Stokes approach? For this last approach, what are the drag coefficients to be used for the tracking of agglomerate of nano-particles/tubes? How are treated the interactions with walls and what are the forces to be taken into account? What is the state of the art concerning the Brownian forces? What are the turbulent scales to be taken into account? How nanoparticles are treated through a shock or in a fluid flowing quicker than the local speed of sound. All these questions will be debated by a panel of selected lecturers. During the LS period, time will also be devoted to present experimental results that present a challenge to understand such as the effect of nanoparticle on surface tension, on heat transfer and in general on the properties of the bulk phase.

## FLOW CONTROL: FUNDAMENTALS, ADVANCES AND APPLICATIONS

MARCH 2-6, 2009

□ Flow control is a key issue for the improvement of the next generation of airplanes, cars and energy generation for a safe and clean environment. The purpose of this Lecture Series is to give the fundamentals of fluid

mechanics, turbulent characteristics of flows in view of control, stability and control theories. The recent advances in control strategies, sensors and actuators for closed loop will then be presented, including low energy plasmas for flow control. Illustrations of successful control for industrial situations, transition, mixing enhancement, drag reduction, vectoring, jet and cavity noise and combustion will be discussed to enhance the applicability to the various fields of research of the attendees.

#### AERODYNAMIC NOISE FROM WALL-BOUNDED FLOWS

MARCH 9-13, 2009

☐ An accurate understanding of the mechanisms of aerodynamic noise from wall-bounded flows is required to predict and subsequently reduce its environmental impact. The aim of this lecture series is to present the state-of-the-art review of the on-going activities in noise prediction and indicate the current research directions. Lectures on the fundamentals of aeroacoustics will be followed by up-to-date reviews on the different theoretical/numerical approaches: DNS, DES, hybrid RANS-LES, SAS and aeroacoustical analogies. Applications will consider aerodynamic noise from boundary layers, cavities, airfoils, airframe devices and internal flows. A synthesis, including a discussion on topics of interest to the attendees, is planned on the last day.

#### LIQUID INJECTION/FRAGMENTATION IN HIGH-SPEED CROSSFLOW

MARCH 16-18, 2009

☐ Liquid injection into compressible crossflow has several interesting applications such as fuel injection in supersonic or hypersonic scramjet engines, thrust vector maneuvering of high speed aerial or space vehicles, and film cooling used in the thermal protection systems of space vehicles that experience atmospheric entry. The field involves many disciplines, and it is a complicated multi-phase flow field especially for compressible crossflow cases, with a unique flow topology including shock-shock and shock-boundary layer interactions. High aerodynamic shear forces, fragmentation, penetration and atomization of the liquid jet are important features that deserve detailed analyses.

The objective of this lecture series is to provide the state-of-the-art information on liquid fragmentation in compressible crossflow. Lectures will include a review of the fundamentals of the phenomena as well as recent advances relevant to the modeling, computation and measurement of the flowfield. Examples of several applications will be presented, by experts of the field from all around the world. The Lecture Series is intended not only to provide suitable training and information to engineers and scientists who wish to enter the field, but also to provide a focal point for technical discussions and an opportunity to exchange views and ideas among engineers and scientists who already work in the field.

#### NUMERICAL INVESTIGATIONS IN TURBOMACHINERY : THE STATE OF THE ART

APRIL 20-24, 2009

☐ The objective of this Lecture Series is to review the latest developments and achievements in the field of computational techniques as applied to turbomachinery flows. Standard and advanced techniques currently used on a routine basis both in the academic and industrial environment are revised, and their merits and shortcomings analyzed on the basis of test problems of practical engineering relevance.

Emphasis is given to the possibility of quantitatively assessing the quality of the computed results, in view of the well known uncertainties arising from numerical and modelling issues. Maturity of pre and post processing systems capable of coping with large size numerical and experimental databases is also considered. The LS is intended to offer to young researchers entering the turbomachinery field a wide and comprehensive view of the currently available computational tools for the aero-thermal performance prediction of modern systems.

#### HIGH PERFORMANCE COMPUTING OF INDUSTRIAL FLOWS

MAY 4-8, 2009

☐ The objective of this lecture series is to provide a state of the art of High Performance Computing strategy applied in Computational Fluid Dynamics. Emphasis will be given to methodology and performance of intensive calculation by pointing out recent progresses in parallel algorithms and sequencing techniques. The new HPC technologies will be also presented. Experts coming from the scientific, industrial and technological communities will discuss their day-to-day experience in generating and handling Mega-Cell-Mesh, in Peta Flops Simulation as well as in processing and visualization of Tera Data. The complex flows to be dealt with will be selected from aerodynamics, aero-acoustics and multiphase problems. The fields to be covered will be automotive, aerospace, chemical processes, pollutant dispersion and nuclear safety.

#### TURBULENT COMBUSTION

MAY 25-29, 2009

☐ The objective of this Lecture Series on Turbulent Combustion is to present the state-of-the-art review of on-going activities in turbulent combustion and to outline current research directions. Introductory lectures on the fundamentals of combustion, and in particular of turbulent combustion, are followed by up-to-date reviews on numerical modeling and experimental results in single and two-phase flows. The lecturers will also give an appraisal of the future challenges and perspectives in the domain. Participants to the lecture series can present a poster of their activities related to turbulent combustion.

#### ADVANCED HIGH TEMPERATURE INSTRUMENTATION FOR GAS TURBINE APPLICATIONS

MAY 11-15, 2009

☐ In aero-engine as well as industrial gas turbines, the drive to higher efficiency is steadily raising the pressures and temperatures in the engines, and this further increases the challenge to instrumentation. Accurate measurements in the hot components of gas turbines (including combustion diagnostics) are recognized as a major need for the assessment of engine component health and performance. High temperature instrumentation is required not only during product development for the validation of new designs or component life prediction methods, but also in service for health monitoring and optimum engine control.

After some introductory basics on measurement chains, errors and uncertainties, this course will therefore address the following topics: measurements of surface temperatures, measurements of gas path pressures and temperatures including steady and unsteady measurement techniques, measurements of blade tip clearance and blade vibration (tip timing and strain gauges) at high temperatures.