

- INTRODUCTION TO MEASUREMENT TECHNIQUES October 7-11, 2013
- ADVANCED POST-PROCESSING OF EXPERIMENTAL AND NUMERICAL DATA NOVEMBER 4-8, 2013
- FLUID MECHANICS AND CHEMISTRY FOR SAFETY ISSUES IN HLM NUCLEAR REACTORS NOVEMBER 25-27, 2013
- ☑ 37TH 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
- SMALL AEROPLANE 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

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 (4 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

For undergraduate student, 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^{rd} & $4^{th_{rm}}$ participant in the same company.

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

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, Website: https://www.vki.ac.be, TVA BE 0407 185 709



ORDER METHODS

SERIES

37TH ADVANCED VKI CFD LECTURE

DEVELOPMENTS IN HIGHER

RECENT

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INTRODUCTION

Computational methods with order of accuracy higher than two have become an important subject of research in CFD, and the perspective of applying them in an industrial aeronautical context is investigated both in Europe (e.g. in the IDIHOM project) and in the US. This lecture series focuses on the technologies that are necessary to make higher order discretization schemes for turbulent high Reynolds number compressible flow really efficient and robust: discretization methods based on Discontinuous Galerkin (DG), Spectral Difference (SD), Spectral Volume (SV), Reconstruction Finite Volume (FV) and Residual Distribution (RD); error analysis and goal oriented error estimation (using adjoint equations) combined eventually with hp-multigrid and hp-adaptive meshes; grid generation for curved boundaries in high Reynolds number applications; implementation aspects of



turbulence modelling and High Performance Computing. Special emphasis is put on industrial applications in the area of steady and unsteady aerodynamics including RANS turbulence modelling (Spalart Allmaras, EARSM) and resolution of turbulence (LES, ILES, DNS). Achievements, weaknesses and perspectives for future research will be critically evaluated.

The course is oriented towards both junior and experienced engineers and researchers involved with CFD algorithm and code development. This implies that the course will be a balanced mix between introductory and advanced lectures.

The Directors of the Lecture Series are Prof. H. Deconinck of the von Karman Institute and Prof. R. Abgrall from INRIA (Bordeaux). The lecturers are top experts from both Europe and North America.

VON KARMAN INSTITUTE

VKI is a non-profit international educational and scientific organisation, hosting 3 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.

The VKI 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.

MONDAY 9 December 2013

- 08:45 Registration
- 09:15 Welcome Address and Introduction *H. Deconinck, von Karman Institute for Fluid Dynamics, Belgium*
- 09:30 Flux reconstruction/correction procedure via Reconstruction, a unified approach to high-order accuracy (1) *H. T. Huynh, NASA Glenn Research Center, USA*
- 11:15 Overview of high-order Finite Volume methods *C. Ollivier-Gooch, U. British Columbia, Canada*
- 14:00 Flux reconstruction/correction procedure via Reconstruction, a unified approach to high-order accuracy (2) *H. T. Huynh*
- 15:45 Error analysis for high-order Finite Volume methods *C. Ollivier-Gooch*
- 17:00 Reception

TUESDAY 10 December 2013

09:00 Discontinuous Galerkin methods for the Reynolds Averaged Navier-Stokes equations, turbulence modeling aspects and applications in aeronautics (1) *F. Bassi, U. Bergamo and S. Rebay, U. Brescia, Italy*

PROGRAM SCHEDULE

- 10:45 Practical implementation and assessment of the discontinuous Galerkin method for DNS and LES of industrial flows (1) *K. Hillewaert, CENAERO, Belgium*
- 14:00 Discontinuous Galerkin methods for the Reynolds Averaged Navier-Stokes equations, turbulence modeling aspects and applications in aeronautics (2) *F. Bassi and S. Rebay*
- 15:45 Practical implementation and assessment of the discontinuous Galerkin method for DNS and LES of industrial flows (2) *K. Hillewaert*
- 17:00 Course Adjourned

WEDNESDAY 11 December 2013

- 09:00 Curved boundary grid generation for high order discretization methods and applications in aeronautics (1) *J.-F. Remacle, U. Catholique de Louvain, Belgium*
- 10:45 High order Residual Distribution Methods (RDM): basic concepts *R. Abgrall, INRIA Bordeaux, France*
- 13:45 High-order output-based adaptive methods for steady and unsteady aerodynamics (1) *K. Fidkowski, U. Michigan Ann Arbor, USA*

- 15:15 Curved boundary grid generation for high order discretization methods and applications in aeronautics (2) *J.-F. Remacle*
- 16:15 Residual Distribution Methods for the Navier-Stokes equations, application to turbulent flows *D. de Santis, U. Bordeaux, France*
- 17:30 Course Adjourned

THURSDAY 12 December 2013

- 09:00 High-order output-based adaptive methods for steady and unsteady aerodynamics (2) *K. Fidkowski*
- 10:45 Higher order and adaptive DG methods for compressible flows (1) *R. Hartmann, DLR Braunschweig, Germany*
- 14:00 Higher order and adaptive DG methods for compressible flows (2) *R. Hartmann*
- 15:45 Status of high order methods for aerospace applications: achievements, weaknesses and perspectives
 - N. Kroll, DLR Braunschweig, Germany
- 16:30 Panel discussion, concluding remarks
- 17:00 Course Adjourned