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 postgraduate education in fluid dynamics (Research Master master-after-master level, Doctoral Programme, Short Training Programme 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 around 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 industry.

The von Karman Institute organizes each year 8 to 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 worldwide recognition for their high quality, which is the result of a careful choice of subjects of current interest and lecturers known for their excellency in that field and willing to cooperate in building up well-structured courses.
The big data and machine learning revolution is gaining traction in the fluid mechanic community and is transforming the way we analyze data and extract knowledge from it. This Lecture Series introduces powerful machine learning methods that are paving the way towards advanced methods for model-order reduction, system identification, estimation, turbulence closures, and flow control.

The course will gather material from various fields, from the data decompositions that were pioneered in fluid mechanics and moves towards methods that were initially developed in machine vision, pattern recognition, and artificial intelligence fields. The covered spectrum of topics will range from introductory material to state-of-the-art research.

The Lecture Series codirectors are Miguel A. Mendez from the von Karman Institute (Belgium), Andrea Ianiro from Universidad Carlos III de Madrid (Spain), Bernd R. Noack from LIMSI-CNRS, Université de Paris-Saclay (FRANCE) and Steven L. Brunton from University of Washington (USA).

The lecture series will host a poster session, which will allow the participants to further exchange and interact with the lecturers. All the participants are encouraged to submit a 1-page abstract before the course.

### Schedule

**Monday 24 February 2020: Coherent Structures**

- 08:30 Registration
- 09:00 Welcome address
- 09:30 Analysis, Modeling and Control of the Cylinder Wake  
  Prof. B.R. Noack, LIMSI, CNRS, Université de Paris-Saclay, France
- 10:45 Coffee Break
- 11:15 Coherent Structures in Turbulent Flows  
  Prof. J. Jiménez, Universidad Politécnica de Madrid, Spain
- 12:30 Lunch
- 14:00 The Proper Orthogonal Decomposition  
  Prof. S.T.M. Dawson, Illinois Institute of Technology, USA
- 15:15 Coffee Break
- 15:45 The Dynamic Mode Decomposition: From Koopman Theory to Applications  
  Prof. P.J. Schmid, Imperial College London, UK
- 17:00 Reception

**Tuesday 25 February 2020: Mathematical Analysis**

- 09:00 Mathematical Tools, Part I: Continuous and Discrete LTI Systems  
  Prof. M.A. Mendez, von Karman Institute for Fluid Dynamics, Belgium
- 10:15 Coffee Break
- 10:45 Mathematical Tools, Part II: Time-Frequency Analysis  
  Prof. S. Discetti, Universidad Carlos III de Madrid, Spain
- 12:00 Poster Session – posters will be on display during the week
- 12:45 Lunch
- 14:00 Generalized and Multiscale Data-Driven Modal Analysis  
  Prof. M.A. Mendez
- 15:15 Coffee Break
- 15:45 Applications and Good Practice  
  Prof. A. Ianiro, Universidad Carlos III de Madrid, Spain
- 17:00 End of day

**Wednesday 26 February 2020: Dynamical Systems**

- 09:00 Modern Tools for the Stability Analysis of Fluid Flows  
  Prof. P.J. Schmid
- 10:30 Coffee Break
- 11:00 Linear Dynamical Systems and Control  
  Prof. S.T.M. Dawson
- 12:15 Lunch
- 14:00 Nonlinear Dynamical Systems  
  Prof. S.L. Brunton, University of Washington, USA
- 15:15 Coffee Break
- 15:45 Methods for System Identification  
  Prof. S.L. Brunton
- 17:00 End of day

**Thursday 27 February 2020: Reduced Order Modelling**

- 09:00 Introduction to Machine Learning Methods  
  Prof. S.L. Brunton
- 10:30 Coffee Break
- 11:00 Machine Learning in Fluids: Pairing Methods with Problems  
  Prof. S.L. Brunton
- 12:30 Lunch
- 14:00 Machine Learning for Reduced-Order Modeling  
  Prof. B.R. Noack, LIMSI-CNRS, France
- 15:15 Coffee Break
- 15:45 Visit of the VKI laboratories
- 17:00 Posters and General Discussion
- 18:00 End of day

**Friday 28 February 2020: Control, Closures and Perspectives**

- 09:00 Reduced-Order Modeling for Aerodynamic Applications and MDO  
  Dr. S. Görtz, German Aerospace Center (DLR), Germany
- 10:15 Coffee Break
- 10:45 Machine Learning for Turbulence Control  
  Prof. B.R. Noack
- 12:00 Lunch
- 13:45 The Computer as Turbulence Researcher  
  Prof. J. Jiménez
- 15:00 Coffee Break
- 15:30 Round Table
- 17:00 End of day

### Online Registration

https://www.vki.ac.be

Please note that the number of participants is limited and admission will be granted on a first come, first served basis. A letter of acceptance and additional information will be sent on receipt of the application form.

50% of reduction as from the 3rd participant from the same company.

**Early Bird Registration** (until November 1st, 2019 included)

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**Late Registration Fee**

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*Type 1: Permanent residents of NATO countries funding VKI: Belgium, Bulgaria, Czech Republic, France, Germany, Greece, Hungary, Iceland, Italy, Luxembourg, Norway, Portugal, Romania, Turkey and the United States

*Type 2: Permanent residents of NATO countries not funding VKI or NATO partner countries

*Type 3: Permanent residents of non-NATO countries

For PhD candidate, 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.