AEROSPACE
SHORT COURSES

Aerodynamic Design Improvements: High-Lift and Cruise (AERO0030)

Instructors: C.P. (Case) van Dam, Paul Vijgen *(This course may be taught by either instructor.)*

Course Highlights

- Aircraft design and the importance of lift and drag on fuel efficiency and GHG emissions
- Reynolds number and Mach number effects on aerodynamic lift and drag
- CFD-based drag prediction and decomposition
- Boundary-layer transition prediction and instrumentation/visualization techniques
- Impact of operational, environmental and manufacturing effects on laminar flow
- Drag reduction techniques including viscous, wave and induced drag
- High-lift physics of multi-element systems
- High-lift wind tunnel and flight testing examples
- Flow separation control and active flow control techniques (cruise and high-lift conditions)

Course Description

This course covers recent advances in high-lift systems and aerodynamics as well as cruise drag prediction and reduction. Includes discussion of numerical methods and experimental techniques for performance analysis of wings and bodies and boundary-layer transition prediction/detection.

Who Should Attend?

Designed for engineers and managers involved in the aerodynamic design and analysis of airplanes, rotorcraft and other vehicles.

Course Outline

Day One

- Aircraft design and the importance of drag on fuel efficiency, operational cost and the environmental impact
- Empirical drag prediction including scale effects on aircraft drag and examples of drag estimates for several aircraft
- History of laminar flow for drag reduction
- Natural laminar flow design, application, certification and viability
- Laminar flow control, hybrid laminar flow control design and application considerations including suction system considerations

- CFD-based drag prediction and decomposition

Day Two

- Critical factors in CFD-based prediction
- Boundary-layer transition prediction and analysis ranging from empirical to Parabolic Stability Equation (PSE) and Direct Numerical Simulation (DNS) techniques
- Supersonic laminar flow including boundary-layer instability, transition mechanisms and control methods at supersonic speeds
- Wave drag reduction at transonic and supersonic conditions
- Passive and active methods for turbulent drag reduction

Day Three

- Induced-drag reduction ranging from classic linear theory to active reduction concepts including wingtip turbines and tip blowing
- Experimental techniques for laminar and turbulent flows
- Impact of high-lift on performance and economics of general aviation and subsonic transport aircraft
- Physics of single-element airfoils at high-lift including types of stall characteristics, Reynolds and Mach number effects

Day Four

- High-lift physics of swept and unswept single-element wings
- Physics of three-dimensional high-lift systems including features of 3D high-lift flows and lessons from high Reynolds number tests
- Importance of boundary-layer transition, relaminarization and roughness (icing, rain) effects on high-lift aerodynamics
- Overview and survey of high-lift systems; types of high-lift systems including support and actuation systems
- High-lift computational aerodynamics methods

Day Five

- Passive and active flow separation control
- Conceptual studies of high-lift systems including multi-disciplinary approaches
- High-lift characteristics of unconventional systems and configurations including canard and tandem-wing configurations, Upper Surface Blowing (USB), Externally Blown Flaps (EBF) and Circulation Control Wings (CCW)
- High-lift flight experiments involving general aviation and transport type airplanes
- Final observations

Classroom hours / CEUs

35.00 classroom hours
3.5 CEUs

Certificate Track
Aircraft Design

Course Fees
Early registration course fee: $2,595 if you register and pay by the early registration deadline (45 days out).

Regular registration course fee: $2,795 if you register and pay after the early registration deadline.

Course Materials
Course materials, including outlines, presentation copies, and supplementary materials, will be accessible through Canvas, KU's online learning system. Instructions to access Canvas will be provided upon completed registration. Students are required to bring a computer or other electronic device with PDF-viewing capabilities with them to class each day. If you require accommodation contact us at professionalprograms@ku.edu and we will work with you on an accessible solution.

U.S. Federal Employee Discount
This course is available to U.S. federal employees at 10% off the registration fee. To receive the federal employee discount, you must enter the code **FGVT116** during the checkout process. Please note that you must validate your eligibility to receive this discount by entering your U.S. government email address (ending in .gov or .mil) when creating your online registration profile. This discount is available for both the early registration and regular registration fees.

Instructor Bios
C.P. "Case" van Dam is Professor Emeritus of Mechanical and Aerospace engineering in the College of Engineering at the University of California at Davis. Before joining UC Davis as an Assistant Professor in 1985, he was employed as a National Research Council (NRC) post-doctoral researcher at the NASA Langley Research Center and as a research engineer at Vigyan Research Associates in Hampton, Virginia. He served as Chair of the Department of Mechanical and Aerospace engineering from 2010 to 2016 and Associate Dean of the College from 2016 to 2019. Van Dam's research focuses on aerodynamic drag prediction and reduction, high-lift aerodynamics, and active control of aerodynamic loads. He has extensive experience in computational aerodynamics, wind-tunnel experimentation and flight testing; teaches industry short courses on aircraft aerodynamic performance and wind energy; has consulted for aircraft, wind energy, and sailing yacht manufacturers; and has served on review committees for various government agencies and research organizations.

Paul Vijgen is an Associate Technical Fellow in aerodynamics engineering at Boeing Commercial Airplanes in Seattle. He currently supports the aerodynamic development of commercial aircraft, focusing on aerodynamic fuel-burn reduction technologies. Starting at NASA Langley in 1985, he was involved with application studies and flight tests of laminar flow and other drag-reduction methods to wings, fuselages and nacelles. Other flight research activities include transport high-lift flows, wake-vortex development and supersonic turbulent flows. Vijgen received an M.S. from the Delft University of Technology, The Netherlands, and a Ph.D. from the University of Kansas, both in aerospace engineering.

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