MAE Graduate Seminar Series

Friday, February 22nd, 2019; 3pm-4pm (JH 109)

Invited Speaker: Dr. Aleksandar Jemcov, University of Notre Dame

Seminar title: Development of the computational framework for predictive fluid flow simulations

Abstract:

Over the past 50 years, computational science has made significant strides towards the better understanding of fundamental physics of fluid flow phenomena. Computational tools are now being used in routine design in aerospace and mechanical engineering. Physical models of turbulence have been developed and applied to many engineering problems in the context of time-averaged and large eddy simulations. However, even with the recent advances in physical models of fluid flow phenomena and increased efficiency of the computational hardware, the original promise of predictive simulations in aerospace and mechanical engineering applications has not been fully realized. The modeling errors associated with time-averaged simulations are too significant to be reliably used in predictive computations and are often used in computing the trends rather than being used in predictive fashion. At the same time, large eddy and direct numerical simulations, due to their costly nature, are still out of reach for fluid flows with large Reynolds numbers. Therefore, the problem seems to be somewhat circular as the more accurate models are too expensive to be used while less accurate models are not sufficient to perform predictive simulations. Therefore, a new approach is needed to resolve this problem. The argument is made that the correct path to addressing the problem of predictive simulations is to develop the scale resolving models of turbulence and high order discretization algorithms suitable for executing simulations on classical (CPU) and modern (GPU) computational hardware. The proposed scale resolving models of turbulence must be completely adaptive and capable of recovering RANS, LES or DNS limits without the user intervention. It is also argued that it is necessary to understand uncertainties associated with the parameters of the scale resolving model to define the bounds on parameters suitable for the class of flows being simulated. Bayesian inference methods and stochastic Gauss process methods together with high-fidelity experimental measurements must be applied to produce validated physical models. Special attention must be paid to the computational efficiency of the new models through the proper usage of the high order of accuracy methods. In this talk, the current work on scale resolving simulations, turbulence model calibration, and uncertainty propagation is presented. The new directions in high-order discretization and algorithmic developments are also discussed.

Bio:

Professor Jemcov has graduated from the University of Belgrade with BSc, MSc, and Ph.D. degrees in aerospace engineering focusing on combustion instabilities in rocket propulsion. He has over twenty years of experience working for Pratt & Whitney Canada, Fluent Inc., and ANSYS Inc. While at Pratt & Whitney Canada, and he has worked as a combustion aerodynamicist on a number of engines that are still in service today. His work in Fluent Inc. and ANSYS Inc. focused on the development of the numerical and physical models in the flagship product Fluent. Professor Jemcov joined the Aerospace and Mechanical Engineering Department at the University of Notre Dame in 2011 in the capacity of the Research Assistant Professor. He teaches several classes including Aircraft Propulsion and Aerospace Dynamics. In addition to his duties within the aerospace and mechanical engineering department, he currently serves in a concurrent position as the Associate Director for Computational Sciences at the Notre Dame Turbomachinery Laboratory where he leads the group of research scientists, and he is responsible for all computational projects within the laboratory. His area of interest includes rocket and gas turbine propulsion, aerodynamics of airplanes, hypersonics, high-fidelity turbulence models, high-order of accuracy discretization methods, and general numerical methods in continuum mechanics.