# MAE Seminar Series

Thursday,
March 25
4:00 pm
Zoom Information
Meeting ID: 983 6137 4638
Password: MAE2021

**Dr. Ashok Gopalarathnam**
Professor
Department of Mechanical and Aerospace Engineering
North Carolina State University

# Modeling, Tailoring, and Sensing of Leading-Edge Vortex Shedding in Unsteady Aerodynamics of Airfoils and Wings

## ABSTRACT

Theoretical and low-order methods for steady, attached flows past wings and configurations have, for many decades, been key enablers for vast improvements in aerospace technology. For unsteady, separated flows past airfoils and wings at high angles of attack undergoing large-amplitude and high-frequency motions, the flow-physics is significantly more complicated and the modeling much more challenging. A typical feature of these flows is the shedding of leading-edge vortices (LEVs). Over the past 10 years, research at NC State has resulted in the development of a so-called leading-edge suction parameter (LESP) that has helped understand LEV formation and shedding on airfoils with round leading edges. We showed that, for a given airfoil and Reynolds number, there is a critical value of the LESP that governs the initiation, growth, and termination of LEV shedding. This critical value is largely independent of motion kinematics for high-rate unsteady motions. Once this critical value is determined for one prototypical motion using CFD or experiment, it can then be used for other similar -rate motion kinematics for that airfoil and Reynolds number. This idea has been used to augment an unsteady thin-airfoil theory with discrete vortex shedding to handle intermittent LEV shedding. Comparisons with CFD and experiments will be presented. Subsequent efforts have shown that the LESP idea can be used to model gust effects and finite-wing LEV formation. Current efforts are focused on designing motion kinematics to tailor LEV shedding, and the use of leading-edge flow sensing to deduce the events associated with LEV formation. Preliminary results from these recent efforts will also be presented.

## BIO SKETCH

Dr. Ashok Gopalarathnam is a Professor in the Department of Mechanical and Aerospace Engineering at North Carolina State University in Raleigh, North Carolina. He received his B.Tech. (1989) and M.S. (1993) in Aerospace Engineering from Indian Institute of Technology, Madras and Ph.D. (1999) in Aerospace Engineering from the University of Illinois at Urbana-Champaign. He has worked on the design and development of the Hansa aircraft at the National Aerospace Laboratories in Bangalore (1991-94), as an aerodynamicist at Scaled Composites in Mojave, California, USA, and as a design consultant on the Cirrus Vision SF-50 personal jet aircraft. He has also made various contributions as a consultant to the design of race car wings and sail boat aero-hydrodynamics. Since 1999, he has led the applied aerodynamics research group at NC State. The group works on design-oriented aerodynamic prediction methods for airfoils, wings, and configurations for air and ground vehicles, and wind power devices. The group's recent efforts are in the development of low-order methods for post-stall and unsteady aerodynamics.