Mechanical Engineering Graduate Student Association (MEGSA)

FAMU-FSU College of Engineering

MECHANICAL ENGINEERING GRADUATE STUDENT ASSOCIATION

POSTDOC SEMINAR

Mechanical and Aerospace Engineering Department

"A Practical Primer on Implementing Modern Stability- and Resolvent-Based Tools in Large-Scale, Legacy CFD Solver"

Speaker: Dr. Rutvij Bhagwat

Dr. Rutvij Bhagwat is a Postdoctoral Scholar in Florida State University and works with Dr. Kourosh Shoele's group. He has been a Research Fellow at the University of Michigan, and has received PhD in Mechanical Engineering from North Carolina State University. His major research has been on resolvent-based methods for flow estimation and control and their application to high-speed turbulent jets, development of stability analysis tools for high-speed flows, modeling fluid structure interactions between turbulent flows and dolphin-skin inspired compliant metasurfaces. His research interests include stability/transition in high-speed flows, reduced-order modeling, turbulent flows, fluid-structure interaction, flow estimation & control, and jet aeroacoustics.

Abstract

Hydrodynamic instabilities and transition to turbulence play a central role in many scientific and engineering applications. Over the last few decades, a number of advances in **hydrodynamic stability theory** such as nonmodal / transient growth and ideas from **control theory** have contributed to the fundamental understanding of these complex processes. Advanced computational tools based on **modern stability theory** can play an important role in **identifying dominant physical mechanisms, building reduced-order models, flow estimation & control, and engineering design of complex flow systems.** However, developing such tools that are capable of addressing complex geometry, non-canonical, aerodynamic and hydrodynamic flows can be challenging. One of the important components of these advanced tools / methods is having access to the **linearized Navier-Stokes (LNS) operator** (and its adjoint) which describes the linearized dynamics of the flow. Having direct access to these operators opens many interesting possibilities for analysis. However, extracting these operators / Jacobians from large-scale, legacy CFD codes is not trivial.

In this talk, a practical template for building these tools into complex, large-scale, parallel CFD solvers will be discussed. The practical aspects of building these tools in legacy codes will be discussed using the examples of two such implementations in a 3D unstructured parallel framework: **a dual-number-based local flux stencil methodology (NCSU)** and **a graph coloring-based approach** (University of Michigan). Several pertinent numerical details / issues, such as the use of limiters, shock-capturing, and exploiting flow symmetries will also be discussed. Finally, some application of these tools to engineering problems of interest will be demonstrated at the end.

...Join us to learn practical aspects of computational tools based on modern stability theory (LNS operator/Jacobians).

Location: AME 106,

Time: Thursday, 16 Apr 2026, 02:00 PM-03:00 PM

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