MECH 4830 Introduction to Aerospace Computational Fluid Dynamics (CFD) Spring 2024

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Course Objectives: The main objective is to provide you with the knowledge and skills necessary (i) to perform CFD using modern software and (ii) to analyze CFD data, with a view to extracting meaningful physics and insight for flows relevant to aerospace engineering.

By the end of this course, you should be able to:

(a) Understand the basic theory of CFD.
(b) Construct CFD models, identify the critical control parameters, and adjust those parameters to suit different flow conditions.
(c) Apply state-of-the-art CFD software to solve realistic flow problems, particularly those in aerospace engineering.
(d) Post-process and analyze CFD data to gain physical insight.

Assessment:
50% Lab 1: Steady flow around a 2D airfoil
50% Lab 2: Unsteady flow around a 2D cylinder
Optional Lab 3: Steady flow around a complex 3D vehicle

Course Outline

1. Introduction + Review of Fluid Dynamics
   - Conservation laws
   - Governing equations: derivation, analysis and physical interpretation
   - OpenFOAM
2. Numerical methods in CFD
   - Finite difference method
   - Finite volume method
   - Spatial and temporal discretization
   - Numerical accuracy
   - Numerical stability
3. Meshing
   - Structured vs. unstructured grid
   - Grid refinement and convergence
4. Turbulence modeling
   - Reynolds-averaged Navier−Stokes (RANS) equations: closure problem
   - Which turbulence model to use?
5. Advanced topics (time permitting)
   - Immersed boundary method
   - High-order numerical schemes
   - CFD for supersonic flows