SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF AEROSPACE ENGINEERING

Subject: 19ASB304 Computational Fluid Dynamics

Title: Fundamentals of Fluid Flow

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Aerospace Engineering

Fundamentals of Fluid Flow

- The fundamentals of fluid flow in CFD is crucial for setting up accurate simulations, interpreting the results, and gaining insights into complex flow phenomena.

- It allows engineers and scientists to optimize designs, improve performance, and make informed decisions in a wide range of applications, including aerospace, automotive, energy, and environmental engineering.

Key aspects of fluid flow

- Governing Equations

- Discretization

- Boundary Conditions

- Turbulence Modeling

- Numerical Solution Techniques

- Validation and Verification

- Post-processing and Visualization

Fundamentals of Fluid Flow

Governing Equations

- The Navier-Stokes equations form the basis for modeling fluid flow in CFD.

- These equations describe the conservation of mass, momentum, and energy for fluid flow. They are partial differential equations that must be solved numerically to obtain the flow field.

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Discretization

- In CFD, the continuous domain is discretized into a computational grid or mesh.

- The governing equations are then approximated using numerical methods, such as finite difference, finite volume, or finite element methods.

- This discretization allows for the calculation of flow variables at discrete points within the domain.

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Boundary Conditions

- Boundary conditions are specified at the boundaries of the computational domain to simulate real-world scenarios.

- These conditions define the behavior of the fluid at the boundaries, such as velocity, pressure, or temperature values.

- They are crucial for obtaining accurate solutions and reflecting the physics of the problem being studied.

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Turbulence Modeling

- Turbulent flows are common in many engineering applications, and accurately modeling turbulence is essential for CFD simulations.

- Various turbulence models are used, ranging from simple algebraic models like the k-epsilon model to more advanced models like large eddy simulation (LES) or Reynolds-averaged Navier-Stokes (RANS) models.

- These models aim to capture the turbulent behavior and its impact on the flow field

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Numerical Solution Techniques

- Once the governing equations are discretized, numerical solution techniques are employed to solve the resulting algebraic equations.

- Common methods include iterative solvers like the Gauss-Seidel method or more advanced techniques like the conjugate gradient method.

- The choice of solver depends on the problem size, computational resources, and desired accuracy.

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Validation and Verification

- CFD simulations need to be validated and verified to ensure the accuracy of the results.

- 1Validation involves comparing CFD results with experimental data or analytical solutions for similar flow cases.

- Verification, on the other hand, focuses on assessing the numerical accuracy of the CFD method itself through techniques like grid convergence studies or order of accuracy analysis.

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Post-processing and Visualization

- After obtaining the CFD results, post-processing and visualization techniques are used to interpret and analyze the flow field.

- This includes generating contour plots, velocity vectors, streamline plots, and other visual representations of the flow variables.

- Post-processing also involves extracting relevant quantities such as forces, heat transfer rates, or pressure distributions.