ST JOSEPH ENGINEERING COLLEGE

An Autonomous Institution

VAMANJOOR, MANGALURU-575 028

Computational Tool for Engineers (22CTE48)

2024-25

Course Project – Airfoil Analysis

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DEPARTMENT OF CSE

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Problem Statement:

To perform aerodynamic analysis of various airfoil using ANSYS Discovery in order to determine the lift and drag characteristics at various angles of attack under subsonic flow conditions.

SDGs linked:

SDG 9: Industry, Innovation and Infrastructure

SDG 13: Climate Action

Introduction:

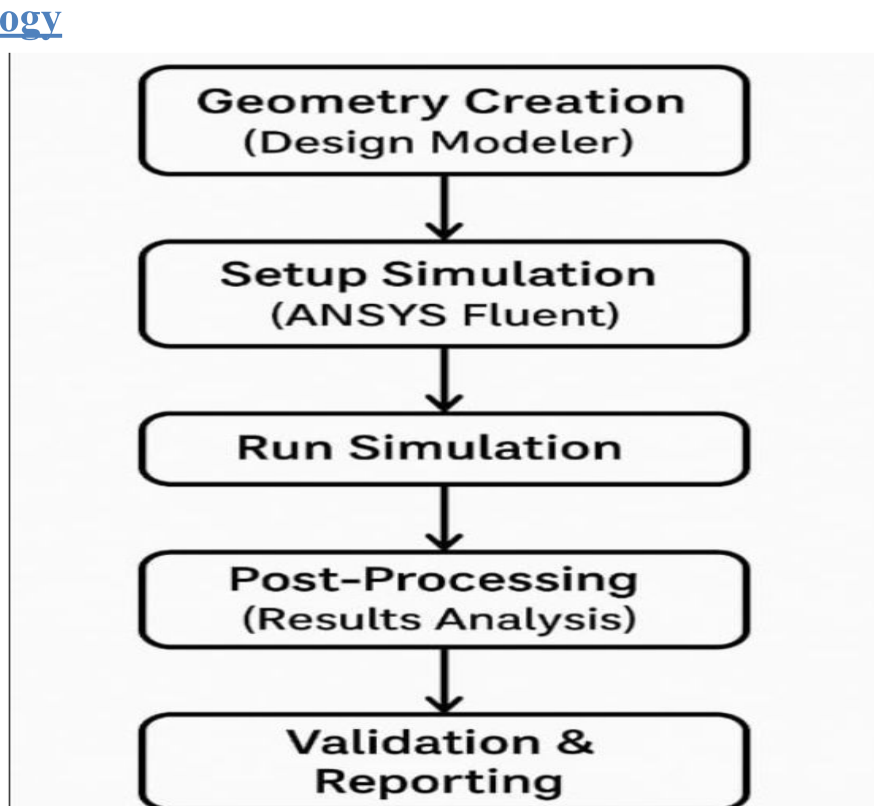
Airfoil analysis using ANSYS Discovery is a powerful method for evaluating the aerodynamic performance of airfoils in various flow conditions. ANSYS Discovery offers an intuitive interface and advanced simulation capabilities to analyze the flow around an airfoil, helping engineers optimize designs for maximum efficiency. With its fast and interactive solver, users can visualize how air interacts with the surface of the airfoil, examining parameters such as pressure distribution, lift, drag, and airflow patterns. This real-time analysis allows for immediate feedback, making it easier to iterate and refine designs quickly.

In addition to providing aerodynamic insights, ANSYS Discovery's meshless simulation approach offers high-fidelity results without the need for complex mesh generation, making it ideal for both beginners and experienced engineers. The tool can simulate different flow regimes, including subsonic, transonic, and supersonic conditions, allowing for a comprehensive understanding of an airfoil behaviour in varying flight scenarios. By using ANSYS Discovery, engineers can enhance the design process, reduce physical prototyping costs, and improve the overall performance and efficiency of aircraft and other aerodynamic systems.

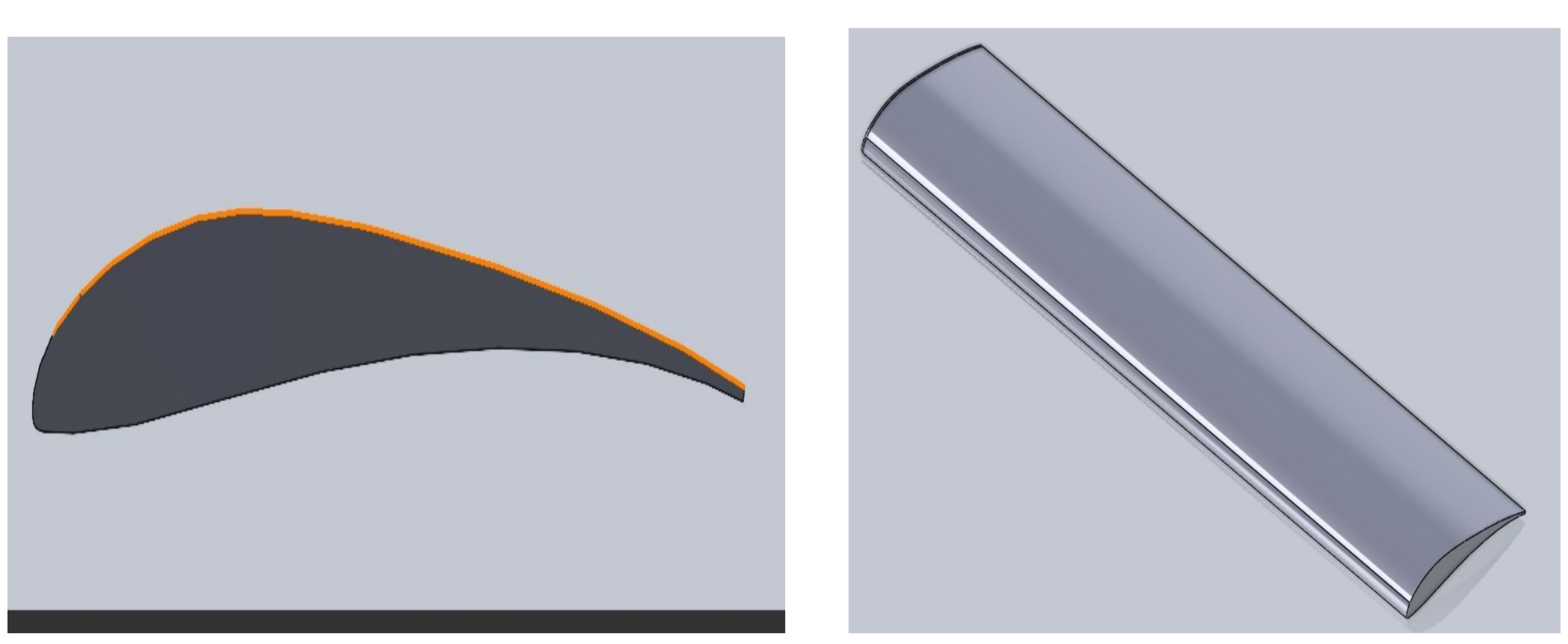
Objectives:

- To perform CFD simulations for NACA 2412 and S1223 airfoils to analyze aerodynamic properties
- To compute stress and strain on both wings under defined loading conditions using structural analysis.
- To compare the aerodynamic efficiency and structural integrity of the two airfoils.
- To interpret the results in terms of performance and cost-effectiveness for practical engineering applications..

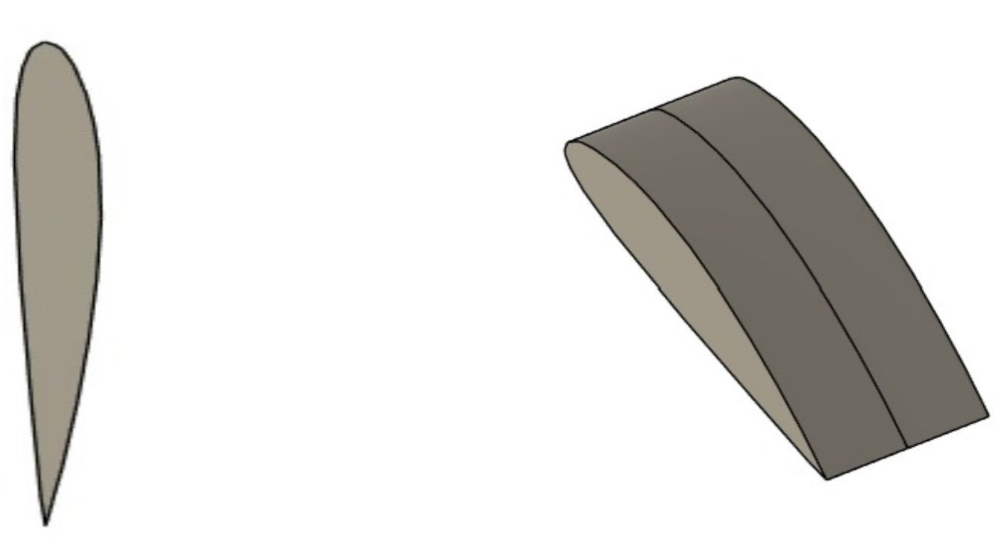
Methodology



Model/sketch/circuit diagram



SI223 Model Design



NACCA 2412

Results and discussion and images:

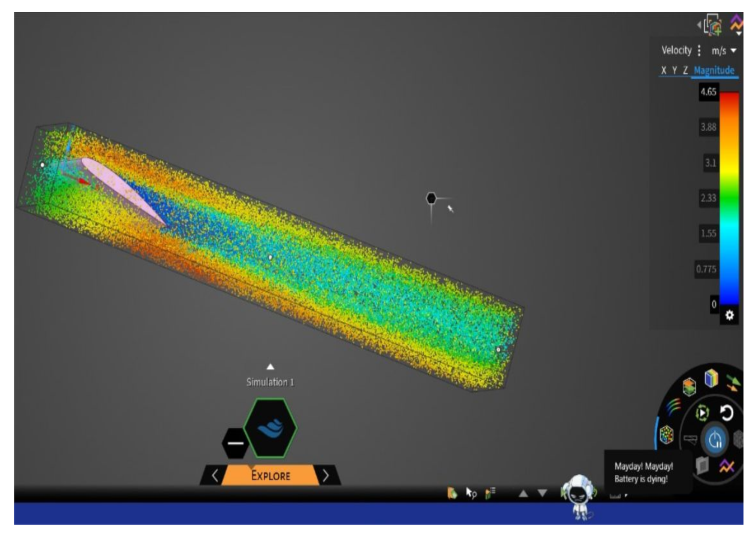


Fig 1-NACA2142-CFD

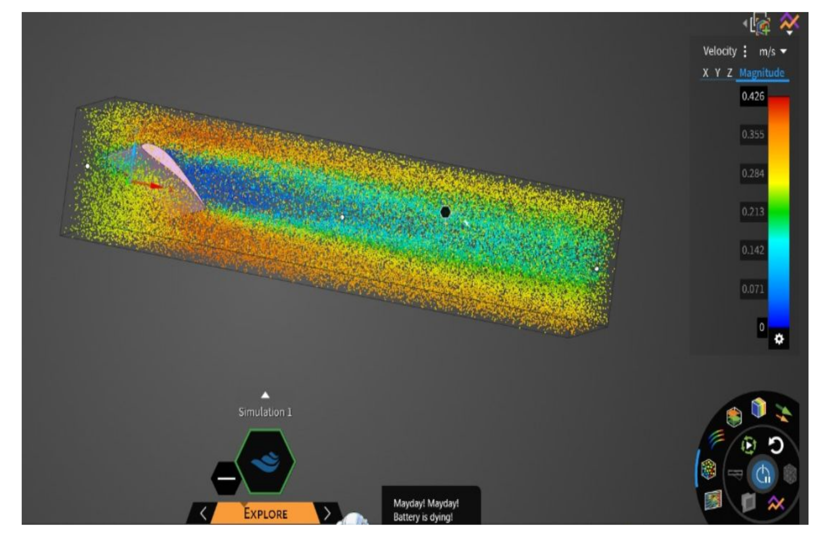


Fig 2-S1223

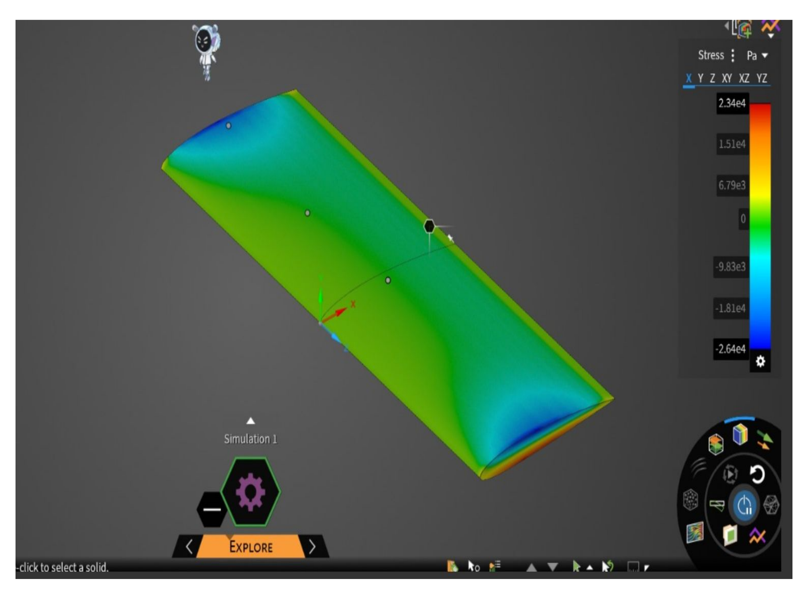


Fig1.1-Principal Stress

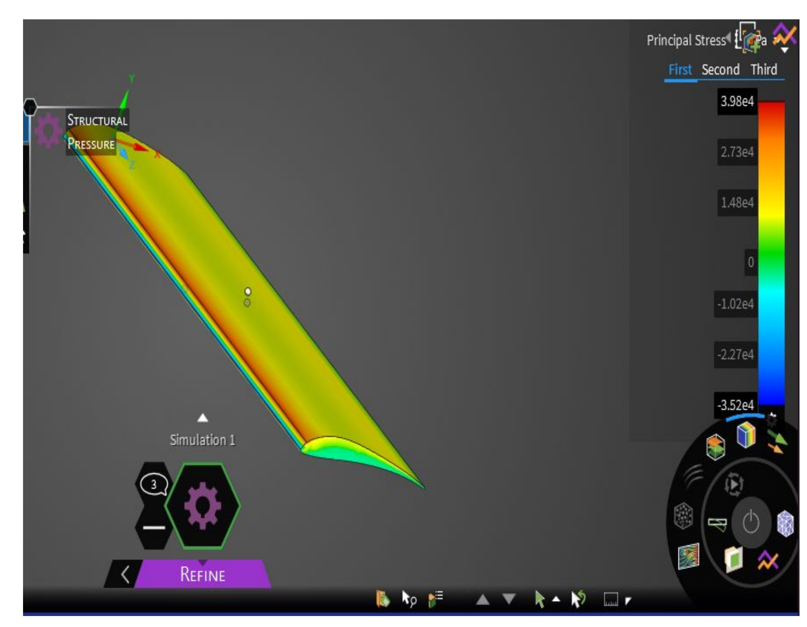


Fig 2.1-Principal Stress

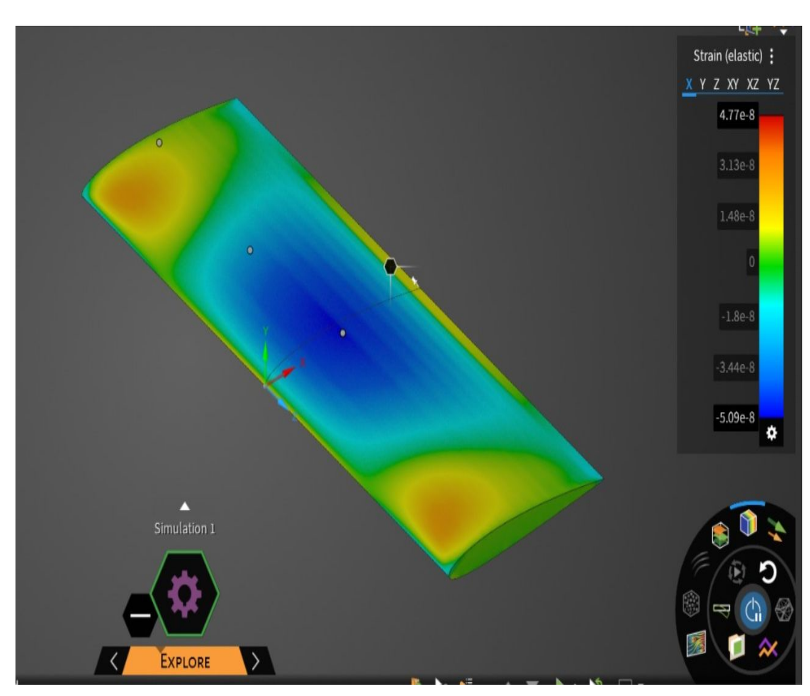


Fig1.2-Strain

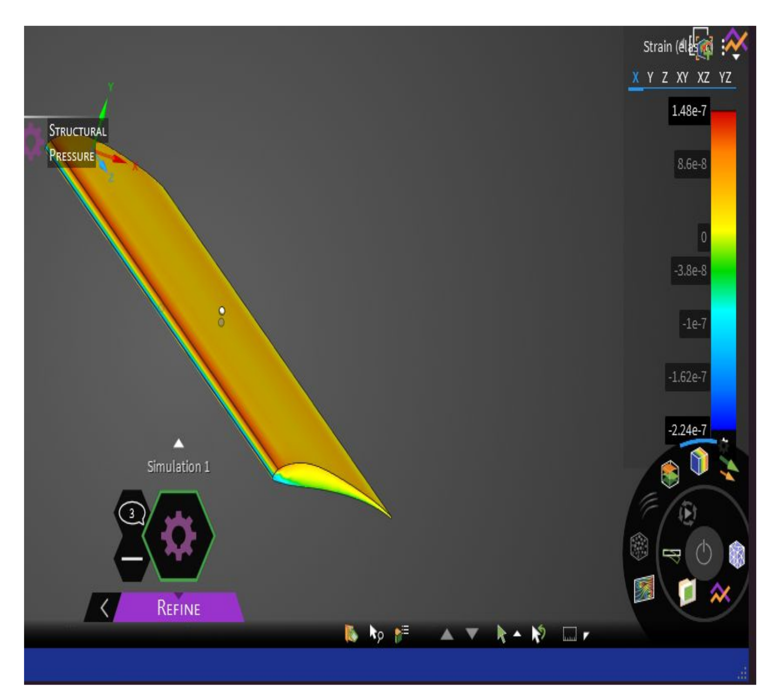


Fig 2.1-Strain

Conclusion

- **Lift and Drag Coefficients**: We measure how much lift and drag the airfoil generates.
- **Pressure Distribution**: We observe how pressure changes across the airfoil's surface.
- **Flow Separation**: We identify areas where the airflow detaches from the surface.
- **Stall Behavior**: We check when the airfoil stalls at high angles of attack.
- **Lift-to-Drag Ratio**: We calculate the lift-to-drag ratio to evaluate efficiency.

Reference:

- https://www.researchgate.net/publication/279186627_Aerofoil_Profile_Analysis_and_Design_Optimisation
- https://youtu.be/W1eTcXMSfuk?si=CZy4ZGOhGp3W_NjK
- T. Ramesh and B. Santhosh, "Aerodynamic analysis of NACA 2412 airfoil using CFD,"