Master Thesis – "CFD based aerodynamic design of a radial compressor impeller and diffuser blade for minimum frontal area" (30 credits/20 weeks – x 1 student)

About us

GKN Aerospace is the world's leading multi-technology tier 1 aerospace supplier. With 55 manufacturing locations in 15 countries, we serve over 90% of the world's aircraft and engine manufacturers. We design and manufacture innovative smart aerospace systems and components. Our technologies are used in aircraft ranging from the most used civil aircraft to the world's advanced 5th generation fighter aircraft and the Ariane orbital rockets used by ESA.

Project Background

Historically small aero-engine applications can utilize an axial-centrifugal compression stage. In such configurations, the low-pressure compressor is typically an axial compressor. The centrifugal compressor is positioned downstream on the same shaft and acts as the high-pressure compression stage.

The main motivation for using a centrifugal stage instead of additional axial stages is related to the design limitations of axial compressors for small engine applications. In the latter stages of an axial compressor, the hub-tip ratio becomes large which leads to correspondingly small blade heights. As a result, a large portion of the blade span is blocked by the end-wall boundary layer, which in-turn reduces the effectiveness of the axial stages. Therefore, a centrifugal stage is often preferred in such applications. These factors erode the efficiency benefits that an axial compressor has over a centrifugal compressor. Typical small engine applications include helicopters, business jets, drones, and auxiliary power units (APUs) in most aircrafts.

This thesis work will contribute to the **RM-X** project, which is an educational platform, focused on developing an aero-engine tailored for small-engine applications. This thesis work will be performed in the "Future Concepts" team at GKN Trollhättan, Sweden.

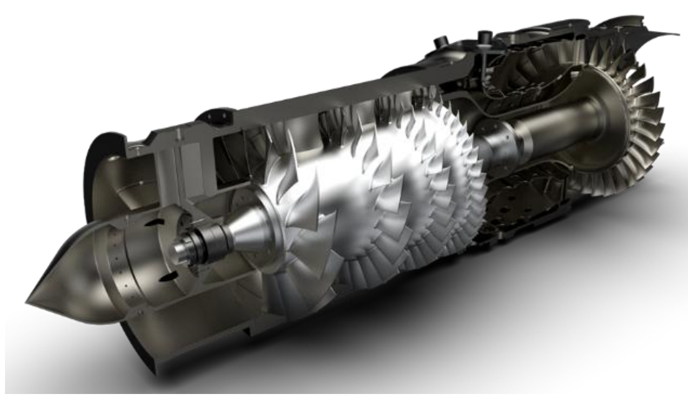

Figure 1: Schematic representation of the RM-Max engine platform

Assignment Description

This thesis work will focus on the aerodynamic design and optimization of the centrifugal stage in an axial-centrifugal compressor for a small jet-engine applications. The aerodynamic design will be carried out using the ANSYS suite of products, with any required programming implemented in Python.

A typical centrifugal stage in small jet-engines delivers compressed air to a downstream combustor. Typically, the centrifugal stage includes a radial impeller, a radial vaned diffuser, an S-duct, and an axial stator. This thesis work will focus only on the impeller and the vaned diffuser. While centrifugal compressors offer key benefits, such as increased overall pressure ratio, reduced axial length and a larger operating range, they also present unique design challenges. One key challenge is minimizing the overall diameter of the impeller and radial vaned diffuser while still achieving the required aerodynamic performance. The diameter of the radial impeller and vaned diffuser determines the maximum frontal area of the engine, which in-turn affects drag and fuel burn of the engine.

In this thesis work, the student will be provided with an existing design of a centrifugal stage, and the goal will be to identify blade design parameters which have a significant effect on the diameter of the impeller and radial vaned diffuser. A bonus outcome would be to setup an optimization framework to minimize the diameter of the impeller and the vaned diffuser within the ANSYS environment.

- **Learning Outcomes and Deliverables**
    - Review literature and understand the design space for existing centrifugal compressors for small jet-engines.
    - Review literature and understand the aerodynamic design process for centrifugal compressors.
    - Evaluate the aerodynamic effect of different blade design parameters on the compressor map.
        - Example: Obtain compressor maps using 3D-CFD for different backsweep angles, lean angles, wrap angles.
    - Setup an optimization framework to mimize diameter once the key parameters affecting the same is identified.
    - Learn several industrially relevant aerodynamic design tools such as BladeGen, Turbogrid, CFX, OptiSLang.
    - Get an overview of the entire blade design process from aerodynamic design requirements to 3D CFD analysis.
    - Presentation at GKN Aerospace

Figure 2: A cutaway view of the HF120 twin-spool aero engine with a centrifugal compressor as the high pressure compression stage

Preferred Qualifications

- Has taken atleast one Master level course in turbomachinery
- Has taken atleast one Master level course in compressible flow
- Is familiar with basic aerodynamics of turbomachines
- Has a working knowledge of running CFD simulations preferably in the ANSYS suite of products

Application Process

Send your **resume and cover letter** including a brief description of previous engineering experience or interests to the below mentioned persons. Remember to mention any previous experience working with turbomachines.

Contact persons to send resume and cover letter:	
Debarshee Ghosh (Main Supervisor)	debarshee.ghosh@gknaerospace.com
Jonathan Bergh	jonathan.bergh@gknaerospace.com

Academic Supervisor: Prof. Tomas Grönstedt (tomas.gronstedt@chalmers.se) from Fluid Dynamics Division at Chalmers University
Last date for application: As soon as possible.
Start Date: The selected student is expected to start in-person from 2nd to 3rd week of January 2026
Location: GKN Aerospace, Tröllhattan, Sweden