Notification No. 591/2025

Dated: 30.12.2025

Name of Scholar: **Mohit Bansal**

Name of Supervisor: **Dr. Abdur Rahim**

Department: Department of Mechanical Engineering

Topic of Research: **Aerodynamics of Combustor/Diffuser Flow Analysis using CFD**

Findings

Based on detailed numerical investigations of a model can combustor under isothermal flow conditions, the following key findings were established for different inlet flow conditions, geometric configurations, and operating parameters:

1. Numerical simulations revealed the formation of a **wall recirculation zone (WRZ)** for both non-swirling and swirling inlet flow conditions. However, the extent and strength of the WRZ were found to be lower in swirling flows due to the radial redistribution of momentum toward the casing wall.
2. A **central recirculation zone (CRZ)** was distinctly observed only under swirling inlet conditions. Non-swirling flows did not exhibit CRZ formation, highlighting the critical role of inlet swirl in inducing axial flow reversal and stabilizing recirculation.
3. The introduction of inlet swirl significantly enhanced **flow uniformity in the annulus region**. Compared to non-swirling flow, swirling flow reduced velocity gradients and improved circumferential mixing downstream of the dump plane.
4. Swirling inlet conditions resulted in a marked improvement in **pressure recovery**, with the pressure recovery coefficient increasing from approximately **23% in non-swirling flow to about 36% in swirling flow**.
5. A corresponding reduction in **total pressure loss coefficient (CL)** was observed with inlet swirl. The pressure loss coefficient decreased from nearly **75% to 67%**, indicating improved aerodynamic performance of the combustor–diffuser system.

6. Parametric analysis of dump gap ratio demonstrated that **optimal aerodynamic performance occurs within a dump gap range of 0.85 to 1.15**, beyond which flow separation and non-uniformity increased.
7. Investigation of casing wall divergence angle showed progressive improvement in annulus flow uniformity with increasing divergence angle. The **optimal divergence angle was identified between 1° and 2°**, beyond which adverse pressure gradients began to deteriorate flow quality.
8. The combined influence of inlet swirl, optimal dump gap, and controlled divergence angle was found to significantly improve **flow stability, pressure recovery, and velocity uniformity**, which are critical parameters for efficient combustor design.