



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai

Accredited by NAAC-UGC with 'A++' Grade (Cycle III) &

Accredited by NBA (B.E - CSE, EEE, ECE, Mech & B.Tech. IT)

COIMBATORE-641 035, TAMIL NADU



DEPARTMENT OF AEROSPACE ENGINEERING

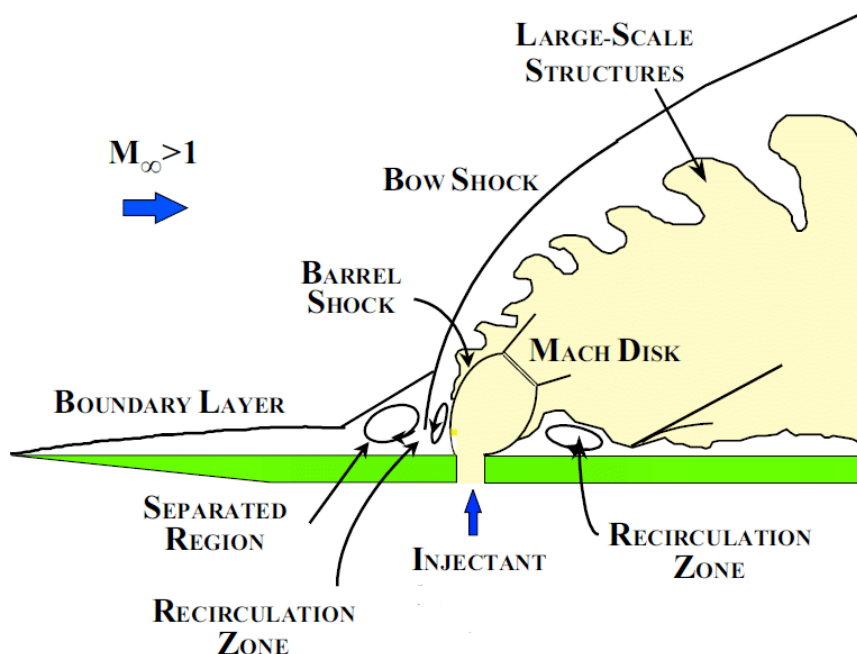
Faculty Name : **Dr.A.Arun Negemiya,** Academic Year : **2024-2025 (Even)**
ASP/ Aero
Year & Branch : **II AEROSPACE** Semester : **IV**
Course : **23ASB201 - Aerospace Propulsion**

UNIT V - PERFORMANCE OF AEROSPACE VEHICLES

Visualization of Secondary Injection in Supersonic Cross Flows

Secondary injection in a supersonic crossflow involves introducing a secondary jet (often fuel) into a high-speed airflow stream, typically for fuel atomization or mixing in scramjet engines, resulting in complex flow phenomena like bow shocks and mixing enhancement.

Key Concepts:



- **Supersonic Crossflow:**

A flow where the fluid (usually air) is moving at a speed greater than the speed of sound.

- **Secondary Injection:**

The introduction of a secondary fluid (like fuel) into the supersonic crossflow.

- **Fuel Atomization:**

Breaking down liquid fuel into fine droplets to improve combustion efficiency.

- **Scramjet Engines:**

Supersonic combustion ramjet engines operate at supersonic speeds.

Flow Phenomena:

- **Bow Shock:**

A shock wave forms in front of the secondary jet as it interacts with the supersonic crossflow.

- **Shock Wave-Boundary Layer Interaction (SWBLI):**

Interactions between the shock waves and the boundary layer (a thin layer of fluid near a surface) can lead to complex flow patterns.

- **Mixing Enhancement:**

The secondary injection can enhance the mixing of the fuel and air, leading to more efficient combustion.

- **Penetration Depth:**

The distance the secondary jet penetrates the crossflow is affected by factors like injection pressure and crossflow conditions.

- **Curved Pylons:**

Using curved pylons can enhance mixing and penetration by creating counter-rotating vortices.

Applications:

- **Scramjet Engines:**

Secondary injection is a common method for fuel atomization and mixing in scramjet engines.

- **Hypersonic Propulsion:**

Understanding and controlling secondary injection is crucial for developing efficient hypersonic propulsion systems.

Research Areas:

- **Mixing Characteristics:** Studying how the secondary jet mixes with the crossflow.
- **Penetration Depth:** Investigating the factors that affect how far the jet penetrates the crossflow.
- **Shock Wave Structures:** Analyzing the formation and behavior of bow shocks and other shock waves.
- **Pylon Geometry:** Exploring different pylon geometries to optimize mixing and penetration.
- **Pulsed Injection:** Studying the effects of injecting the secondary fluid in a pulsed manner.