

PROPULSION LABORATORY

The Propulsion Laboratory is an essential component of undergraduate education in Aeronautical and Aerospace Engineering, providing students with practical exposure to the fundamental principles and operating characteristics of aircraft and rocket propulsion systems. The laboratory complements theoretical learning by enabling students to understand, observe, and experimentally evaluate the performance of various propulsion components and systems.

The laboratory is designed to familiarize students with the construction and working principles of air-breathing propulsion systems, along with the basic principles of rocket propulsion. Through laboratory experiments, students gain practical knowledge of parameters such as thrust, pressure, temperature, heat transfer, airflow, rotational speed and overall propulsion-system performance.

The experiments conducted in the Propulsion Laboratory help students develop skills in experimental measurement, data acquisition, performance analysis, interpretation of results, and technical reporting. Students learn to operate propulsion-related test rigs and instruments safely, identify the major components of propulsion systems, and correlate experimental observations with theoretical predictions.

The laboratory also provides an opportunity for students to study important propulsion phenomena such as compressor and turbine cascade performance, combustion, nozzle flow and thrust generation. Wherever applicable, computational and analytical methods can be integrated with experimental investigations to strengthen students' understanding of propulsion-system design and performance.

List of Facilities available:

1. Propeller Test Rig
2. Forced & Free convection Apparatus
3. Low speed Cascade Wind Tunnel
4. Axial Flow Compressor
5. Burning velocity measurement Apparatus
6. Injectors Test Facility

Propeller Test Rig

The propeller test rig is used to measure the thrust produced by the propeller at different speeds. The facility also explores the effect of pitch angle on the thrust force.

Specification and items available:

1. 2-Bladed Aluminum propeller with variable pitch and wooden propeller with constant pitch
2. 3-Bladed Wooden variable pitch propeller.
3. Diameter of propeller 600 mm.
4. Drive: Variable speed electric motor of suitable capacity.
5. Thrust: The whole assemble of motor is mounted on a linear bearing motion shaft with housing (free suspension) and load cell with digital thrust indicator.
6. Speed: Measured using a digital speed indicator
7. Air velocity: measured by a digital anemometer.
8. Control panel: consists of speed controller, digital speed indicator, digital Thrust indicator and necessary mains indicator and it is isolated from the test bench.
9. The Whole assembly is housed inside the circular duct with sturdy base frame



Test Section of the propeller test rig



Control Module of the Propeller test rig

Forced & Free convection Apparatus

The setup is used to find the free and forced convective heat transfer rate over a given model. The set up is also used to calculate the influence of model orientation and velocity on convective heat transfer rate.

Specification and items available:

Uniformly heated airfoil model (NACA 0015) & Span of 150mm (Aluminum) maintained at constant temperature by using heat control.

Pencil heater: capacity of 250 Watts.

Digital temperature indicator & channel selector with thermocouples on heated surface.

Digital Voltmeter & Ammeter or digital power meter for heat input measurement.

Provision for mounting the plate in any position.

The whole instrumentation is mounted on control board/table as a self-contained unit.



Forced & Free convection Apparatus

Low Speed Cascade Wind Tunnel

A low-speed cascade wind tunnel is an experimental facility used to investigate the aerodynamic performance of cascades of airfoils, particularly those representing the blade rows of axial-flow compressors and turbines. It provides a controlled airflow through a series of stationary, geometrically similar airfoil blades arranged in a periodic passage called a cascade.

The facility is primarily used to study pressure distribution, velocity variation, flow turning, aerodynamic losses, incidence effects, and blade loading under different operating conditions. By varying parameters such as inlet flow angle, blade angle, pitch-to-chord ratio, and flow velocity,

the aerodynamic characteristics of compressor and turbine blade profiles can be experimentally evaluated.

A typical low-speed cascade wind tunnel consists of a blower/fan, settling chamber, flow-conditioning section, contraction, cascade test section, and diffuser. Suitable measuring instruments such as pressure taps, manometers, Pitot tubes, and angle-measuring devices are used to obtain experimental data.

The tests can also be conducted on cascades with different blade cross-sections with different orientations of the blades. Cascade testing of a model of axial compressor blade row and turbine cascade is carried out.

Specifications and items available:

Air velocity: 20 m/s

Material: Mild Steel

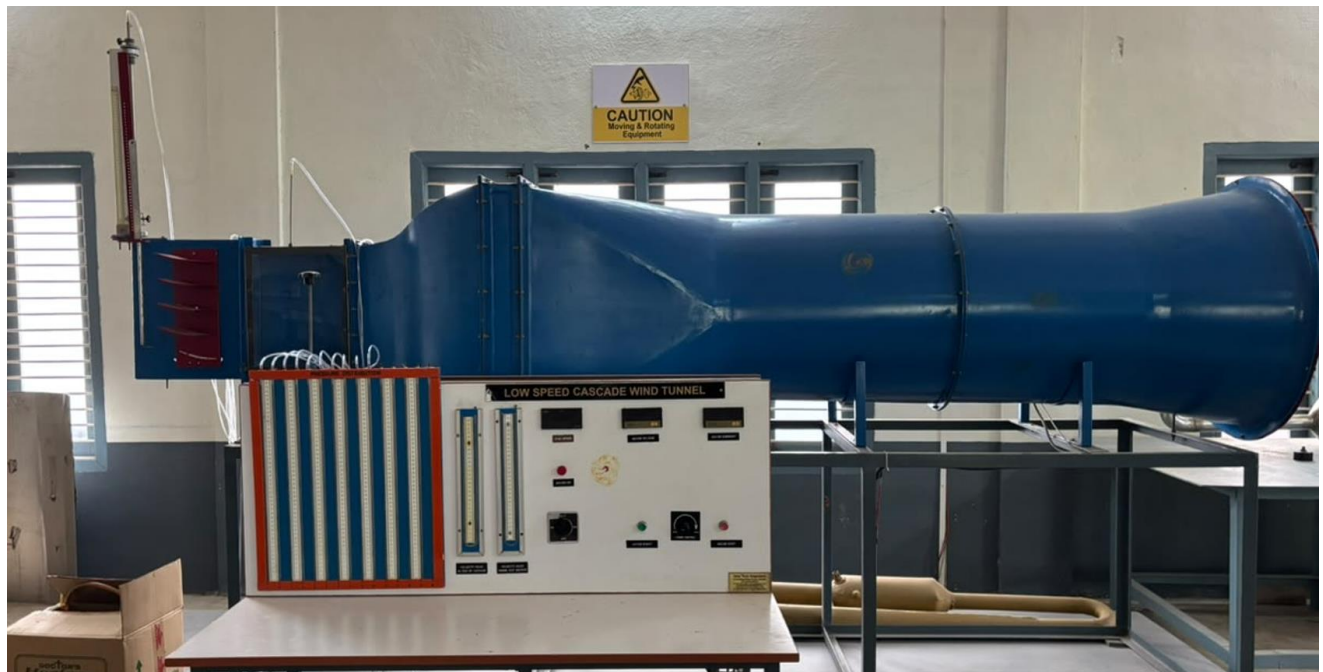
Inlet: Bell mouth inlet

Test section: 120 mm × 400 mm

Fan: Axial flow fan 600 mm Driven by DC motor

Drive: Variable speed Thyristor Controller

Motor capacity: 3HP



Low Speed Cascade Wind Tunnel

Cascade details:**Compressor cascade**

No. of airfoils: 5
Axial chord: 12cm
Aspect ratio: 1.25
Total turning: $\pm 30^\circ$

Turbine cascade

No. of aero foils: 5
Axial chord: 10cm
Aspect ratio: 1.5
Total turning: $\pm 30^\circ$

Instrumentation

Prandtl type pitot – static tube with traverse in vertical direction with differential manometer
Instrumented cascade blade (pressure tapings of 10 points) connected to multi-tube manometer for pressure distribution study.
Speed of the blower fan is measured by digital indicator with sensor.

Axial Flow Compressor Test Rig

An Axial Flow Compressor Test Rig is an experimental setup used to study the performance and operating characteristics of axial-flow compressors, which are widely employed in aircraft gas turbine engines and industrial gas turbines. In an axial compressor, air flows predominantly in the axial direction through successive rows of rotor and stator blades, where its pressure is progressively increased.

The test rig enables students to experimentally investigate important compressor parameters such as pressure ratio, mass flow rate, rotational speed, temperature rise, power consumption, isentropic efficiency, and compressor performance characteristics. By varying the operating conditions, students can observe the effects of flow rate and rotational speed on compressor performance.

In the axial flow compressor test rig present in our laboratory, students can conduct performance test on the four-stage axial flow compressor.

Specification and items available:

Number of stages :4
Inlet section :300mm diameter
Outlet section :180 mm diameter

Motor capacity :3 HP AC motor with 2,800 rpm

Power measurement: By energy meter

VFD / AC Drive

Control panel



Axial Flow Compressor Test Rig

Burning velocity measurement Apparatus

This facility enables the understanding of basic combustion phenomenon and also the influence of variable volume flow rate of fuel and air on burning velocity.

Specification and items available:

Specially designed burner with wire mesh to generate a laminar pre-mixed flame.

Gaseous fuel from the fuel supply (LPG gas cylinder) through an orifice in to the mixing chamber.

Gas (LPG) Rotameter with control valve for gas flow.

Air flow Rotameter with control valve for air flow.

Mini gas cylinder is supplied along with the setup.

Glass chamber for clear visualization.



Burning Velocity Measurement setup

Injector Test Facility

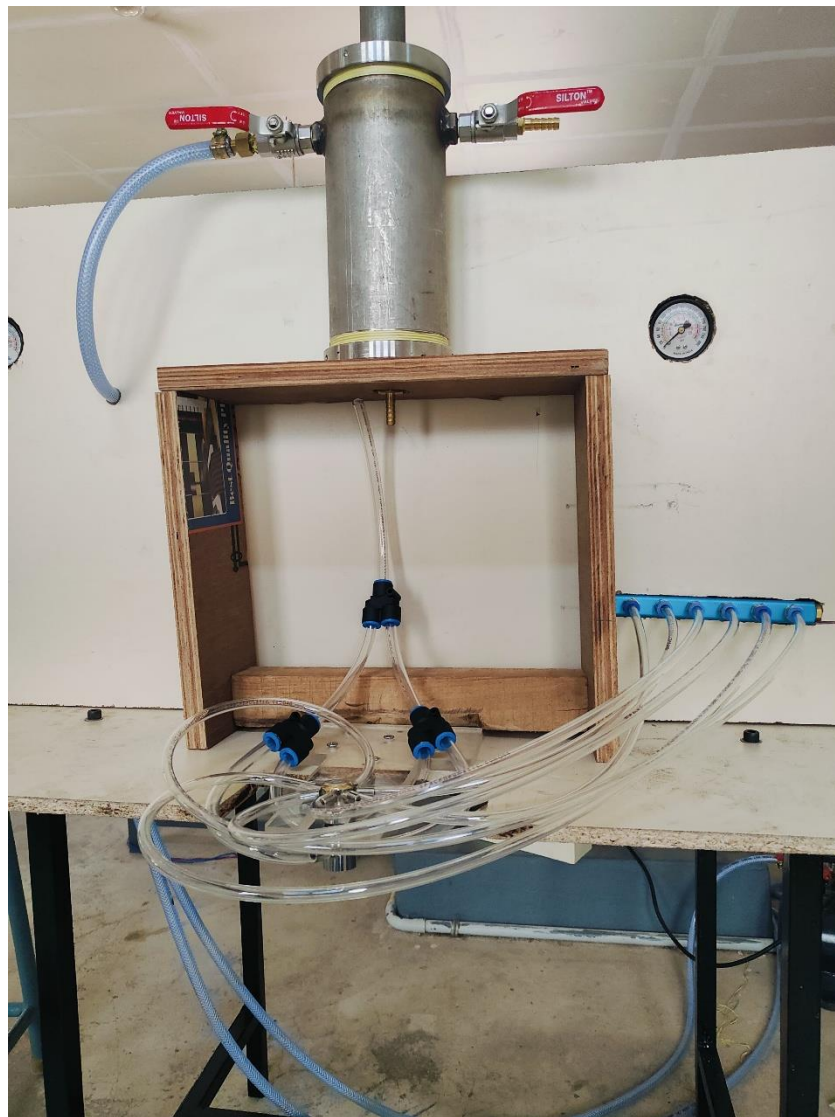
An Injector Test Facility is an experimental setup used to study the working characteristics and performance of fuel injectors used in aircraft engines, gas turbines, and other combustion systems. The injector is responsible for delivering fuel into the combustion chamber in a controlled manner and producing an appropriate spray pattern for effective mixing and combustion.

The facility enables students to investigate important injector characteristics such as fuel flow rate, injection pressure, spray pattern, spray angle, atomization quality, and fuel distribution under different operating conditions. It helps students understand the influence of injection pressure and injector geometry on fuel atomization and combustion performance.

A typical injector test facility consists of a fuel tank, pump, pressure-regulating system, injector assembly, pressure gauges, flow-measuring device, and spray chamber or collection

system. The setup allows students to safely conduct experiments and record the relevant operating parameters.

The facility provides undergraduate students with practical knowledge of fuel injection, atomization, spray formation, and combustion-system requirements, thereby connecting theoretical concepts studied in Aircraft Propulsion, Gas Turbine Engineering, and Combustion with practical laboratory experience.



The injector test setup



Sample test of the atomization behavior

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Research Areas

- **Atomization behavior of fuels**
- **Propeller Designs**
- **Compressor and Turbine blade designs**