



PHOENICIA UNIVERSITY

The Thermal Fluids Field

How engineers convert, transfer, and utilize energy through heat, work, and the motion of liquids and gases.

Mechanical Engineering Program | Foundations of Thermal-Fluid Sciences

1 What Is the Thermal Fluids Field?

The Thermal Fluids field focuses on how energy is converted, transferred, and utilized through concepts related to heat and work, as well as liquids and gases.

Students study thermodynamics, fluid mechanics, and heat transfer to understand and design systems that efficiently manage energy and temperature.

THREE CORE DISCIPLINES

Thermodynamics

How heat and work convert into one another within a system.

Fluid Mechanics

How liquids and gases move, and the forces that drive them.

Heat Transfer

How thermal energy moves between objects, fluids, and surroundings.



2 From Physics Principles to Engineering Equations

Every principle in this field builds directly on conservation laws you already know — engineering just formalizes them into tools powerful enough to design real systems.

Energy → First Law of Thermodynamics

The conservation of energy becomes the First Law of Thermodynamics, used to analyze engines, air-conditioning systems, and power plants.

Momentum → Navier-Stokes Equations

The conservation of momentum evolves into the governing equations of Fluid Mechanics, predicting airflow over wings, pumps, and industrial equipment.

Mass → Continuity Equation

The conservation of mass becomes the Continuity Equation, essential for designing pipelines, fuel injectors, and HVAC duct networks.

3

The First Law of Thermodynamics

What It States

Energy cannot be created or destroyed — only converted between forms, such as heat and work. The First Law formalizes the conservation of energy into a precise accounting tool for any system exchanging heat and work with its surroundings.

ENGINEERING APPLICATION

Powering Engines, Power Plants, and A/C Systems

Applied thermodynamics

Engineers apply the First Law to analyze internal combustion engines, air-conditioning systems, and power plants — tracking exactly how much heat goes in, how much work comes out, and where energy is lost along the way.

Why It Matters

Every efficiency rating on an engine or power plant traces back to a First Law energy balance between heat in, work out, and losses.

Lesson: nothing is truly “lost” in an energy system — it's converted somewhere the engineer must find.



The Navier-Stokes Equations

What They State

The conservation of momentum, applied to a moving fluid, becomes the Navier-Stokes equations — a set of governing equations describing how velocity, pressure, and viscosity interact at every point in a fluid.

ENGINEERING APPLICATION

Predicting Airflow, Pumps, and Industrial Flow

Applied fluid mechanics

These equations let engineers predict airflow over an airplane wing, water flow through a pump, and fluid motion inside industrial equipment — often solved numerically using computational fluid dynamics (CFD).

Why It Matters

Aircraft, turbines, and piping systems are all shaped by solutions — exact or approximate — to these equations.

Lesson: fluid behavior looks chaotic, but it still obeys the same conservation law as a rolling ball.

5

The Continuity Equation

What It States

The conservation of mass, applied to a flowing fluid, becomes the Continuity Equation: mass entering a system must equal mass leaving it, plus any change in storage. It links a fluid's velocity to the changing cross-section it flows through.

ENGINEERING APPLICATION

Designing Pipelines, Injectors, and HVAC Ducts

Applied continuity principles

The Continuity Equation is essential for designing pipelines, fuel injection systems, and heating, ventilation, and air conditioning (HVAC) duct networks — ensuring a system delivers the right flow rate at every point.

Why It Matters

A duct network sized without the Continuity Equation risks delivering the wrong airflow to the very room a building needs it most.

Lesson: what goes in must come out — the simplest conservation law is often the easiest one to get wrong in a design.



6 Three Governing Laws, Side by Side

Conservation Law	Governing Equation	Key Applications
Conservation of Energy	First Law of Thermodynamics	Engines, power plants, air-conditioning systems
Conservation of Momentum	Navier-Stokes Equations	Aircraft wings, pumps, industrial flow
Conservation of Mass	Continuity Equation	Pipelines, fuel injectors, HVAC ducts

7 Beyond These Examples

These principles are utilized in a wide range of applications, which are not limited to the examples covered in this lecture.

Students learn to analyze and design thermal fluid systems that provide cleaner and more energy-efficient solutions to problems in their local community and the world.

THE BROADER GOAL

Cleaner, more energy-efficient solutions — for the local community and the world.



8 Why This Matters for Future Mechanical Engineers

Builds on What You Know

High school conservation laws for energy, momentum, and mass become the exact same laws engineers use professionally — just formalized.

Powers Real Systems

Every engine, pump, aircraft, and HVAC network in operation today was designed using these same three governing principles.

Solves Real Problems

Mastering these tools lets engineers design cleaner, more efficient systems for their community and the world.





“Energy is neither created nor destroyed — only transformed.”

— The First Law of Thermodynamics