

**Department Of Mechanical
Engineering**

Fluids Mechanics-1 (MIME 2240)

**Chapter-1
Introduction to Fluids Mechanics
and Fluid Properties**

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Definition

- **Mechanics** is the oldest physical science that deals with both stationary and moving bodies under the influence of forces.
- The branch of mechanics that deals with bodies at rest is called **statics**, while the branch that deals with bodies in motion is called **dynamics**.
- The subcategory fluid mechanics is defined as the science that deals with the behavior of fluids at rest (fluid statics) or in motion (fluid dynamics), and the interaction of fluids with solids or other fluids at the boundaries.
- The study of fluids at rest is called **fluid statics**

Understanding better

- The study of **incompressible fluid** under static conditions (hydrostatics)

- That dealing with the compressible static gases - aerostatics

STATICS



- Deals with the - **velocities, accelerations and pattern of flow only**

- Force and energy causing velocities and accelerations

KINEMATICS



- Deal with the **relationship** between velocities and accelerations of fluid with the **FORCES @ ENERGY** causing them.

DYNAMICS



Definition

- The study of fluids in motion, where pressure forces are not considered, is called fluid **kinematics** and if the pressure forces are also considered for the fluids in motion that branch of science is called fluid **dynamics**.
- Fluid mechanics itself is also divided into several categories.
- The study of the motion of fluids that are practically **incompressible** (such as liquids, especially water, and gases at low speeds) is usually referred to as **hydrodynamics**.
- A subcategory of hydrodynamics is **hydraulics**, which deals with liquid flows in pipes and open channels.

Definition

- **Gas dynamics** deals with the flow of fluids that undergo significant density changes, such as the flow of gases through nozzles at high speeds.
- The category **aerodynamics** deals with the flow of gases (especially air) over bodies such as aircraft, rockets, and automobiles at high or low speeds.
- Some other specialized categories such as **meteorology**, **oceanography**, and **hydrology** deal with naturally occurring flows.

What is a Fluid?

- A substance exists in three primary phases: **solid, liquid, and gas**.
- A substance in the liquid or gas phase is referred to as a **fluid**.
- Distinction between a solid and a fluid is made on the basis of the substance's ability to resist an applied shear (or tangential) stress that tends to change its shape.
- A solid can resist an applied shear stress by deforming, whereas a fluid deforms continuously under the influence of shear stress, no matter how small.
- In solids stress is proportional to strain, but in fluids stress is proportional to strain rate.

What is a Fluid?

- *When a constant shear force is applied, a solid eventually stops deforming, at some fixed strain angle, whereas a fluid never stops deforming and approaches a certain rate of strain.*

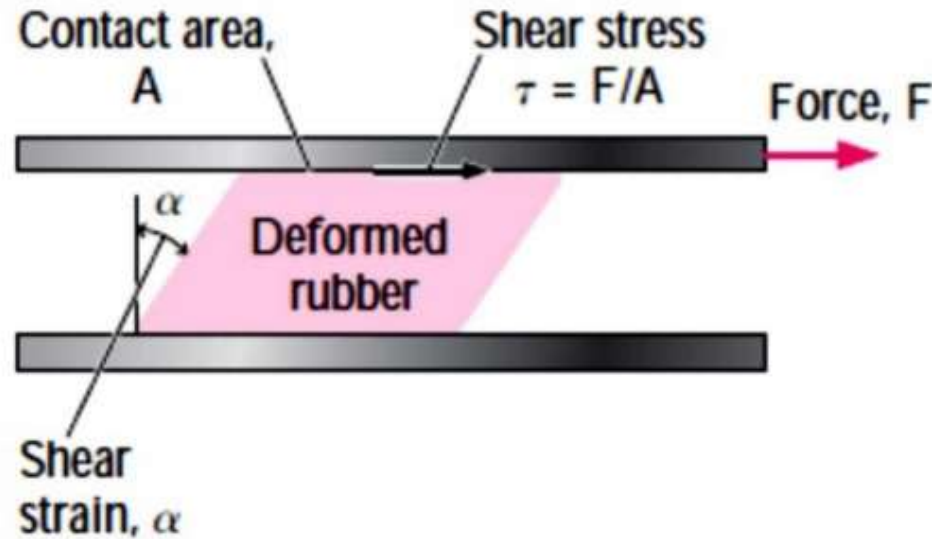


Figure.
Deformation of a rubber eraser placed between two parallel plates under the influence of a shear force.

What is a Fluid?

- In a liquid, molecules can move relative to each other, but the volume remains relatively constant because of the strong **cohesive forces** between the molecules.
- As a result, a liquid takes the shape of the container it is in, and it forms a free surface in a larger container in a **gravitational field**.
- A gas, on the other hand, expands until it encounters the walls of the container and fills the entire available space.
- This is because the gas molecules are widely spaced, and the cohesive forces between them are very small.
- Unlike liquids, gases cannot form a free surface

Differences between liquid and gases

Liquid	Gases
Difficult to compress and often regarded as incompressible	Easily to compress – changes of volume is large, cannot normally be neglected and are related to temperature
Occupies a fixed volume and will take the shape of the container	No fixed volume, it changes volume to expand to fill the containing vessels
A free surface is formed if the volume of container is greater than the liquid.	Completely fill the vessel so that no free surface is formed.

Application areas of Fluid Mechanics

Mechanics of fluids is extremely important in many areas of engineering and science.

Examples are:

Biomechanics: Blood flow through arteries and veins, Airflow in the lungs, Flow of cerebral fluid

Households: Piping systems for cold water, natural gas, and sewage, Piping and ducting network of heating and air- conditioning systems, refrigerator, vacuum cleaner, dish washer, washing machine, water meter, natural gas meter, air conditioner, radiator, etc.

Meteorology and Ocean Engineering: Movements of air currents and water currents

Application areas of Fluid Mechanics:

- **Mechanical Engineering:** Design of pumps, turbines, air-conditioning equipment, pollution-control equipment, etc. Design and analysis of aircraft, boats, submarines, rockets, jet engines, wind turbines, biomedical devices, the cooling of electronic components, and the transportation of water, crude oil, and natural gas.
- **Civil Engineering:** Transport of river sediments, Pollution of air and water, Design of piping systems, Flood control systems
- **Chemical Engineering** : Design of chemical processing equipment

Application areas of Fluid Mechanics:

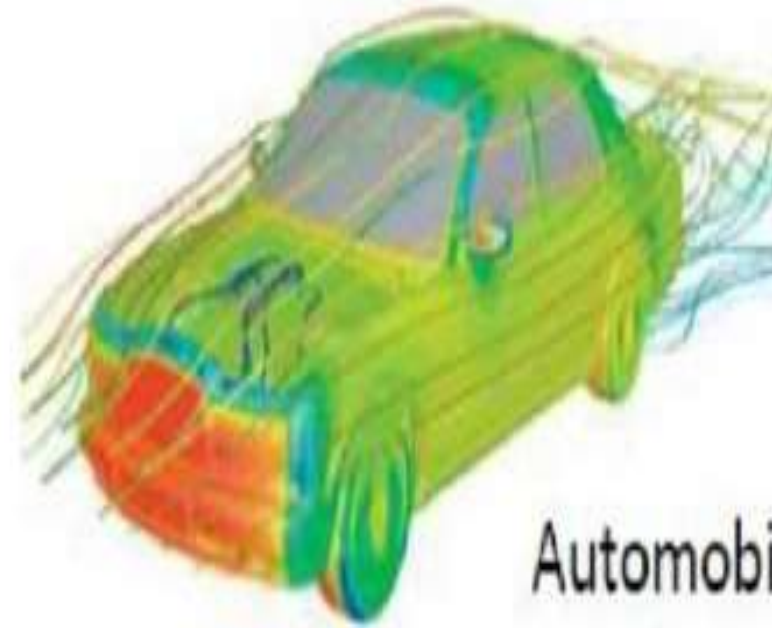
- **Turbomachines:** pump, turbine, fan, blower, propeller, etc.
- **Military:** Missile, aircraft, ship, underwater vehicle, dispersion of chemical agents, etc.
- **Automobile:** IC engine, air conditioning, fuel flow, external aerodynamics, etc.
- **Medicine:** Heart assist device, artificial heart valve, Lab-on-a-Chip device, glucose monitor, controlled drug delivery, etc.
- **Electronics:** Convective cooling of generated heat.
- **Energy:** Combuster, burner, boiler, gas, hydro and wind turbine, etc.

Application areas of Fluid Mechanics:

- **Oil and Gas:** Pipeline, pump, valve, offshore rig, oil spill cleanup, etc.
- Almost everything in **our world** is either in contact with a fluid or is itself a fluid.
- The number of fluid engineering applications is enormous: breathing, blood flow, swimming, pumps, fans, turbines, airplanes, ships, rivers, windmills, pipes, missiles, icebergs, engines, filters, jets, and sprinklers, to name a few.
- When you think about it, almost everything on this planet either is a fluid or moves within or near a fluid.

Application areas of Fluid Mechanics:

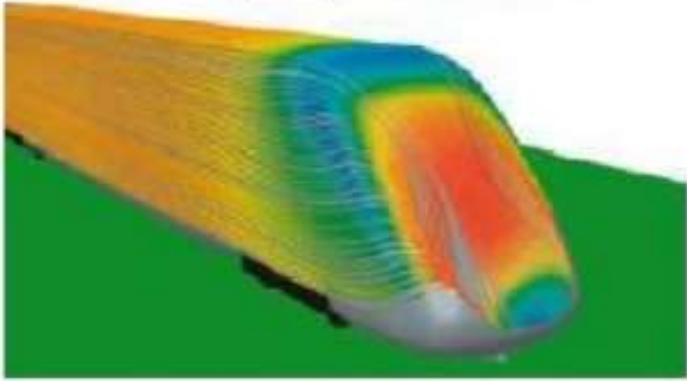
Missile
aerodynamics



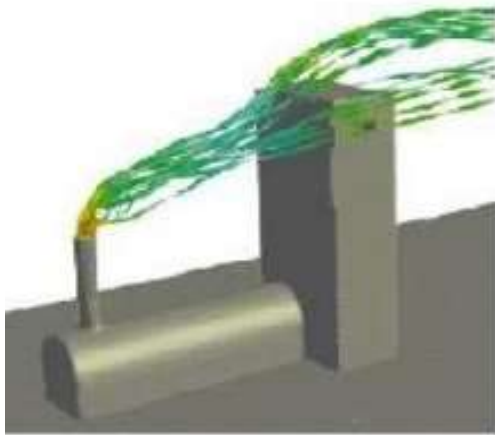
Automobile
aerodynamics

Application areas of Fluid Mechanics

High speed train

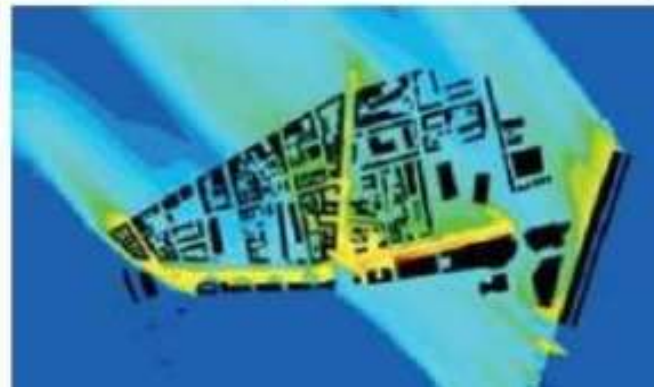


Wind turbines

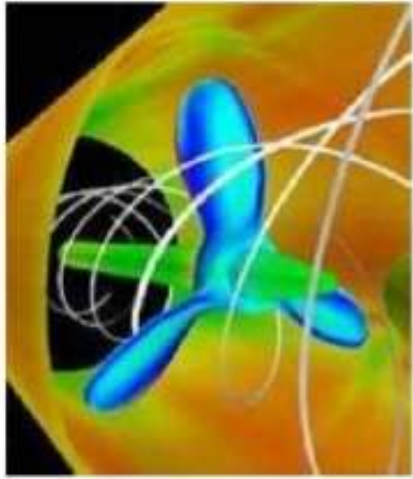


Smoke from a stack

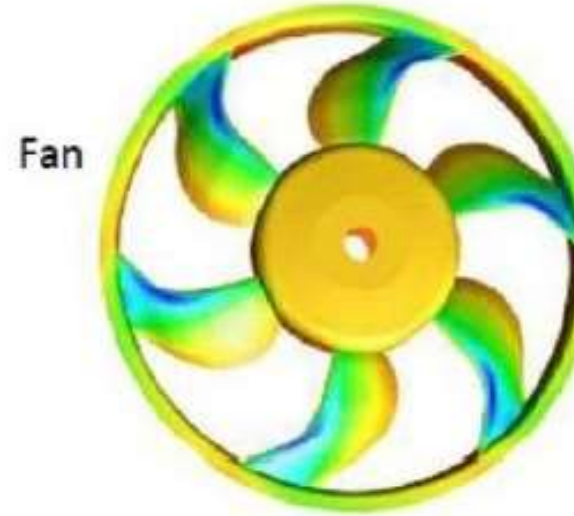
Pollutant dispersion over a city



Application areas of Fluid Mechanics

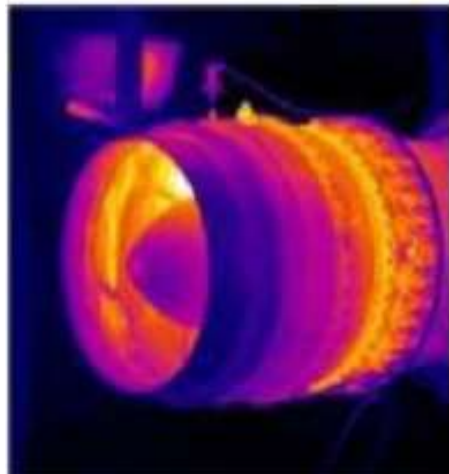


Propeller

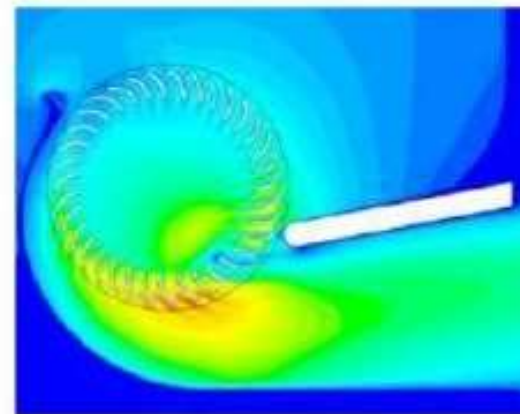


Fan

Centrifugal Pump



Jet Engine
Propulsion

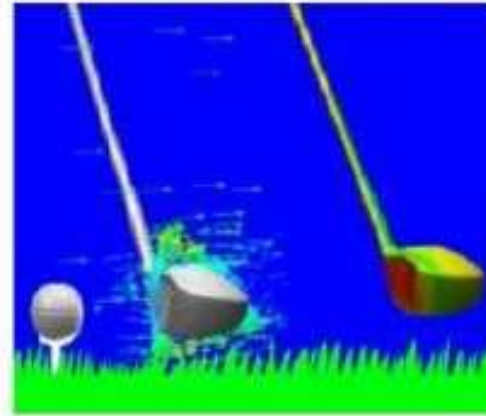


Crossflow fan

Application areas of Fluid Mechanics



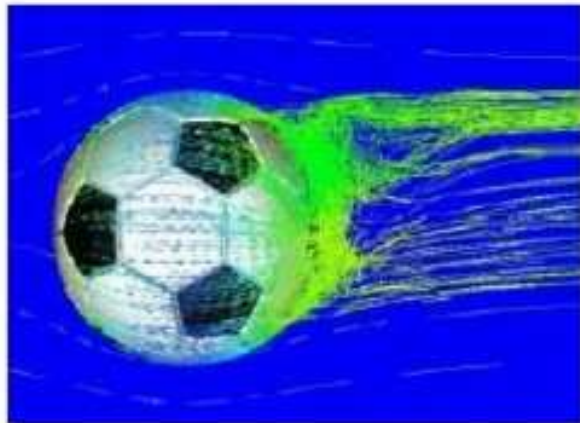
Ski Jumping



Golf



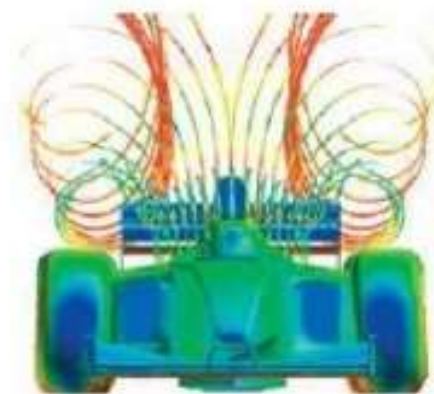
Swimming



Football



Cycling



Indy Car Racing

THANK YOU!

for your attention

