Ch1-1 Introduction and Big Idea

Objectives: Reading: 1.1

- Fluid Definition (Identify and Explain)
- Fluid Mechanics (Big Idea) (Identify and Explain)
- Continuum (Identify and Explain)

Why should we learn fluid mechanics? (Show slides)

- What we see is either fluid or object surrounded by fluid. Fluid is everywhere in our life.
- The knowledge of fluids promotes the technological progress of human society.

Exampl 1: Building: skyscraper: { wind (outdoor air); HVAC (indoor air, air quality, thermal comfort); water supply and drainage; ... }

Example 2: Sports balls

banana kick of soccer ball (Free kick)

baseball, tennis, ping pong, etc.

Example 3, COVID 19

How far may the droplets from a cough travel in the air?

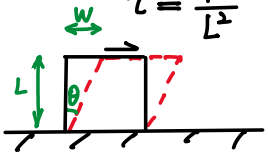
What is a fluid?

- Discussion: all about fluid
- Intuition: it flows.

> A fluid is defind as a substance that deforms continuously when acted on by a shear stress of any magnitude. ☆

Solid:

shear stress, $\tau \doteq \frac{F}{L^2}$



$\gamma = \frac{W}{L} = \tan\theta \approx \theta$ (shear strain)

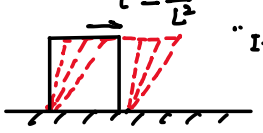
$\tau = \gamma \cdot G$ (shear modulus)

$G \doteq \frac{F}{L^2}$

- A solid can resist an applied shear by a static deformation.
- "Elasticity" resists deformation.

Fluid:

$\tau \doteq \frac{F}{L^2}$



"It flows."

- "Viscosity" resists the deformation.

$\mu \doteq \frac{F}{L^2} \cdot T$

What is fluid mechanics?

"Big Idea" of Fluid Mechanics

Force and Motion. e.g. $\Sigma F = ma$

Newton's Second Law of Motion.

Fluid mechanics is the science that studies the force and motion of fluids.

"Big Idea" of Fluid Mechanics. ☆

$\Sigma F = ma$ applied to fluids

ΣF: 4 key forces
* pressure
* gravity
* Viscous effect (Text 1.6)
* Surface tension (Text 1.9)

ma: Acceleration. or Inertia.

Fluid mechanics
- Fluid Statics (at rest): Ch2
- Fluid Dynamics (in motion): Ch3, Ch5-10

(Fluid Kinematics focuses on various aspects of fluid motion w/o being concerned w/ the forces necessary to produce/change the motion. Ch 4)

Continuum.

* It is not practical to study the behavior of individual molecules when trying to describe the behavior of fluids at rest or in motion.

* A fluid is treated as continuum. Fluid mechanics characterizes the behavior of fluid, e.g. velocity, by the average evaluated over a small volume containing a large number of molecules. ☆

Examples:

* The velocity of fluid at a given position (Eulerian description) is the average velocity of all fluid molecules in a tiny volume at this position. The volume is so tiny that it can be considered a

point. However, there are still many fluid molecules inside the volume.

* The velocity of a given fluid particle <Lagrangian description> is the average velocity of all fluid molecules within the fluid particle. The fluid particle is an ideal model used to describe the behavior of fluid. A fluid particle is a small parcel of fluid. It is very small and can be considered a point. However, there are still many fluid molecules inside the fluid particle.
* Eulerian description and Lagrangian description will be discussed in Chapter 4.