

# Dimensions and Units in Fluid Mechanics

- A *dimension* is a measure of a physical variable.
  - In fluid mechanics, there are four *primary dimensions*: mass, length, time, and temperature. Primary dimensions are defined as independent dimensions, from which all other dimensions can be obtained. They are listed below, along with their symbols.

Dimension	White's symbol	<u>Cimbala's</u> symbol
Mass	M	m
Length	L	L
Time	T	t
Temperature	$\theta$	T

- All other dimensions in fluid mechanics (called *secondary dimensions*) can be constructed from combinations of these four primary dimensions.
  - It is customary to use brackets around a variable to indicate its dimensions. For example "{Power}" means "the dimensions of power."
  - Example - Dimensions of Force - Force is not a *primary* dimension in fluid mechanics. Yet, force (and any other secondary dimension used in fluid mechanics) can be written as a combination of the four primary dimensions, i.e. in

terms of mass, length, time, and temperature.

$$\text{The dimensions of force are } \{\vec{F}\} = \{m \cdot \vec{a}\} = \left\{ m \cdot \frac{L}{t^2} \right\} = \left\{ \frac{mL}{t^2} \right\}.$$

- Example - Dimensions of Power - Power is not a *primary* dimension in fluid mechanics. Yet, power (and any other dimension used in fluid mechanics) can be written as a combination of the four primary dimensions, i.e. in terms of mass, length, time, and temperature.

$$\text{The dimensions of power are } \{\dot{W}\} = \left\{ \frac{\text{work}}{\text{time}} \right\} = \left\{ \frac{\text{force} \cdot \text{length}}{\text{time}} \right\} = \left\{ \frac{(mLt^{-2}) \cdot L}{t} \right\} = \left\{ \frac{mL^2}{t^3} \right\}.$$

- Dimensions have no numbers associated with them.
- A **unit** is a way to assign a number or measurement to a dimension.
  - There are three primary unit systems in use:
    - the International System of Units (SI units - kg, N, m, s, K)
    - the English Engineering System of Units (commonly called English units - lbm, lbf, ft, s, R)
    - the British Gravitational System of Units (BG - slug, lbf, ft, s, °R)
  - Units must always have numbers associated with them.
  - For example, length is a *dimension*, but it is measured in *units* of feet (ft) or meters (m).

Source:

[http://www.mne.psu.edu/cimbala/Learning/Fluid/Introductory/dimensions\\_and\\_units.htm](http://www.mne.psu.edu/cimbala/Learning/Fluid/Introductory/dimensions_and_units.htm)