# Thermodynamics (ESC-S202)

## Lecture -1 & 2

## Introduction of Thermodynamics

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# Course contain of ESC-S202

- Fundamental concepts: System , Property, Work and Heat interactions.
- Zeroth law: Zeroth law of thermodynamics, Temperature and its measurement scales.
- First law: Thermodynamic processes, calculation of work in various processes, non flow work and flow work. Joule's experiment.
- First law of thermodynamics applied to open systems, study flow system and their analysis. Applications to closed systems and flow processes. Analysis of unsteady processes. Limitations of first law of thermodynamics, PMM1.
- Thermodynamics properties of fluids.
- Second law: Devices converting heat to work, Thermal reservoir, heat engines efficiency, Devices converting work to heat, heat pump, refrigerator, COP, Reversed heat engine, Kelvin plank statements, Clausius statement, reversible and irreversible processes, Carnot cycle ,PMM2.
- Entropy , Availability , equilibrium Criterion , Maxwell Relations Thermodynamics relations , Clapeyron equation , Gibb's Phase rule.

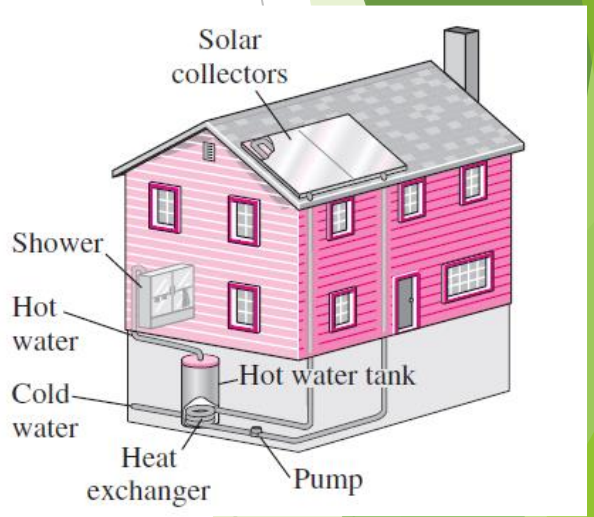
# Introduction of Thermodynamics

## Thermodynamics

- It stems from Greek words- therme (heat) and dynamis (power).(Effort to convert heat into power)
- It is the science of energy transfer and its effects on the properties of the system.

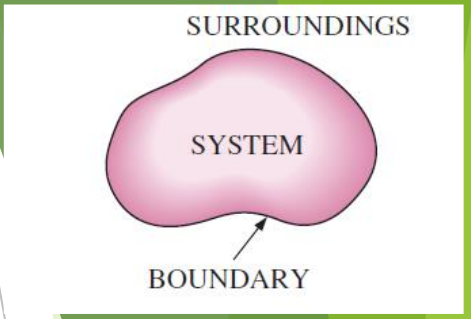
## Application fields of Thermodynamics

- Human body
- The heating and air conditioning systems
- Design and analysis of automotive engines
- Conventional and Nuclear power plant
- Solar collectors
- Design and analysis of energy efficient homes




**Design of Engineering systems**

[Source-Thermodynamics an Engineering Approach-Y. Cengel]




## System

- A system is defined as a quantity of matter or a region in space chosen for study.

## Surrounding

- The mass or region outside the system is called the surroundings.

## Boundary

- The real or imaginary surface that separates the system from its surroundings is called the boundary. The boundary of a system can be fixed or movable.

## Types of System

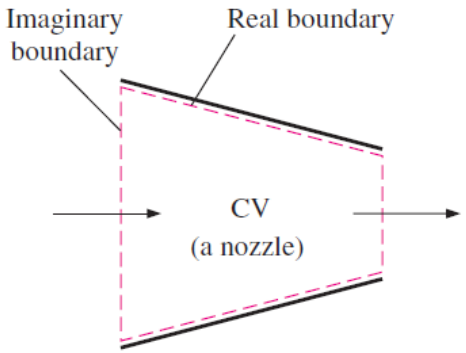
- There are three types of systems:-

| S. No. | Type of System | Energy Transfer | Mass Transfer | Example |
|---|---|---|---|---|
| 1. | Open System | Yes | Yes | Turbine, Compressor, pump etc. |
| 2. | Closed System | Yes | No | Piston- Cylinder device etc. |
| 3. | Isolated System | No | No | Universe, Well insulated thermoses etc. |

- Closed System is also known as control mass system.
- Open System is also known as control volume system or flow system.

# Control Surface

- The boundaries of a control volume are called a control surface, and they can be real or imaginary.




**Control Volume with real and Imaginary boundary**
[Source-Thermodynamics an Engineering Approach-Y. Cengel]

# Properties of the System

- Any characteristic of a system is called a property.
- There are two types of properties

1. Intensive Properties

- These properties are independent of the mass of a system, such as temperature, pressure, and density.

2. Extensive Properties

- Those properties whose values depend upon mass of the system. Total volume, total momentum are some examples of extensive properties.

## Important points Regarding Intensive and Extensive properties

- Uppercase letters are used to denote extensive properties (with mass $m$ being a major exception), and lowercase letters are used for intensive properties (with pressure $P$ and temperature $T$ being the obvious exceptions).
- Extensive properties per unit mass are called **specific properties.** Some examples of specific properties are specific volume ($v = V/m$) and specific total energy ($e = E/m$). All specific properties are Intensive properties.

## Continuum

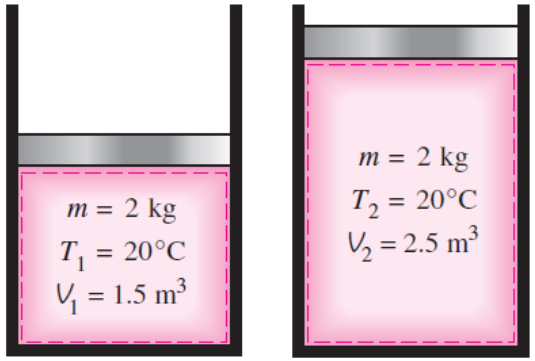
- It is very convenient to disregard the atomic nature of a substance and view it as a continuous, homogeneous matter with no holes, that is, a **continuum.** The continuum idealization allows us to treat properties as point functions and to assume the properties vary continually in space with no jump discontinuities.

## Rarefied gas flow theory

- At very high vacuums or very high elevations, the mean free path may become large (for example, it is about 0.1 m for atmospheric air at an elevation of 100 km). For such cases the **rarefied gas flow theory** should be used, and the impact of individual molecules should be considered.

# State

- At a given state, all the properties of a system have fixed values. If the value of even one property changes, the state will change to a different one.




(a) (b)

**A system a two different states**

[Source-Thermodynamics an Engineering Approach-Y. Cengel]

# Equilibrium

- The word **equilibrium** implies a state of balance. In an equilibrium state there are no unbalanced potentials (or driving forces) within the system. A system in equilibrium experiences no changes when it is isolated from its surroundings.

# Thermodynamic Equilibrium

- A system is lie in thermodynamic equilibrium, if only if all the relevant type (below mention) equilibrium are satisfied.

1. Thermal Equilibrium

- A system is in **thermal equilibrium** if the temperature is the same throughout the entire system.

2. Mechanical Equilibrium

- **Mechanical equilibrium** is related to pressure, and a system is in mechanical equilibrium if there is no change in pressure at any point of the system with time.

3. Chemical Equilibrium

- A system is in **chemical equilibrium** if its chemical composition does not change with time, that is, no chemical reactions occur.