# Engineering Thermodynamics

## Lecture 1

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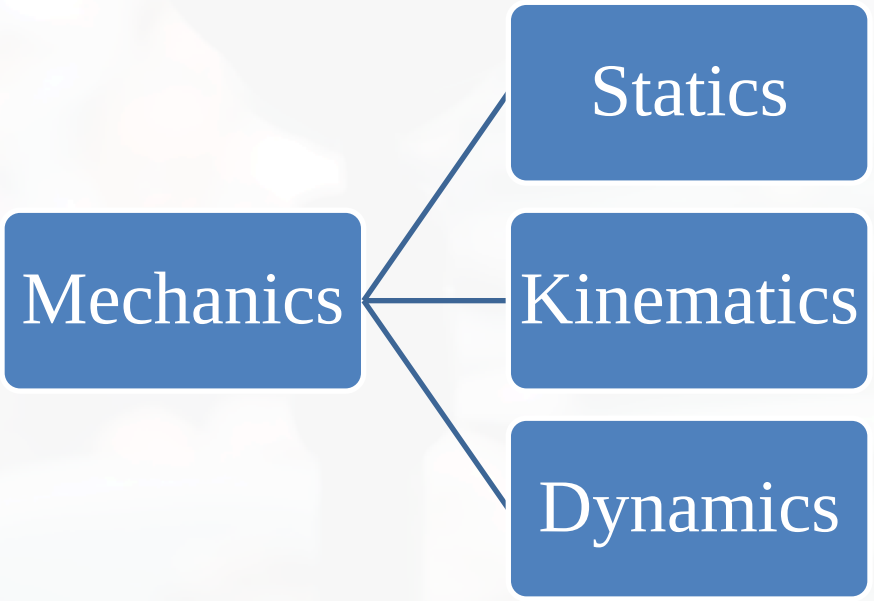
Thermodynamics Originates from Two Greek Words

| Therme | + | Dynamikos |
| --- | --- | --- |
| (Heat) | | (Dynamics i.e. force) |




Study when body is at rest

Study of motion without considering the basic cause of motion i.e. Force

Study of motion with considering the basic cause of motion i.e. Force

(Newton's Second law)

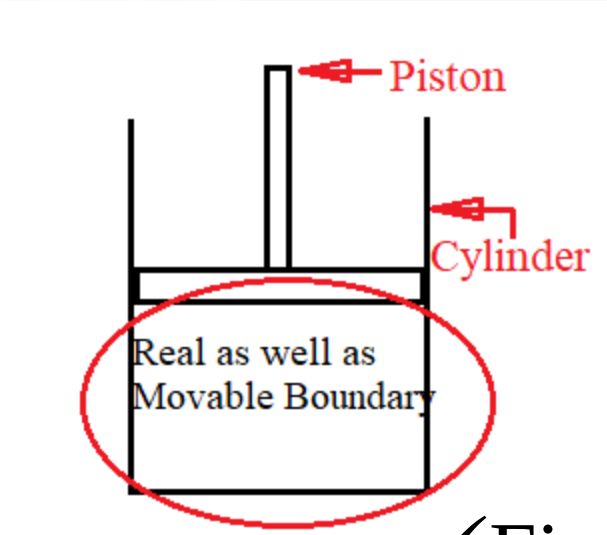
- The Science which deals with the relation among heat, work and properties of system and their effects on the properties of substances.
- Based upon the observations of common experiences, which have been formulated into thermodynamics laws.
- Also based upon the laws governed by the nature.

*Practical applications: Power Generation, Engines, Refrigerators, Air Conditioners, Gas turbines, Jet propulsion, Fuel cell, pumps, Heat exchangers, Human body etc.*

# Thermodynamic System

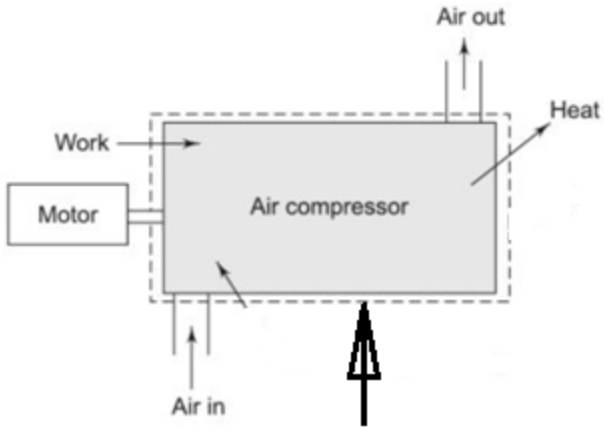
Surroundings

System Boundary




- ✓Fixed
- ✓Movable

- ✓Real
- ✓Imaginary

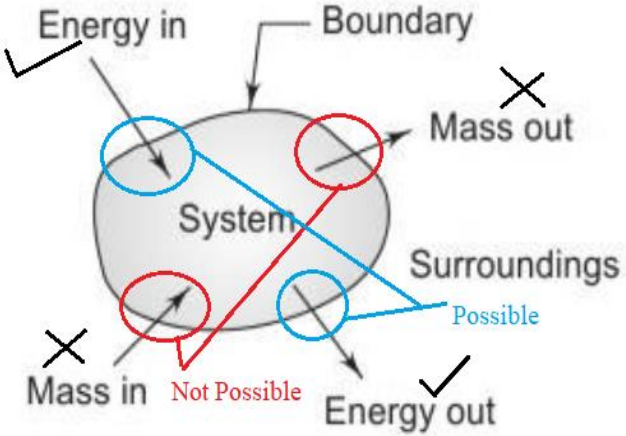



Example of fixed as well as imaginary Boundary

# Thermodynamic System

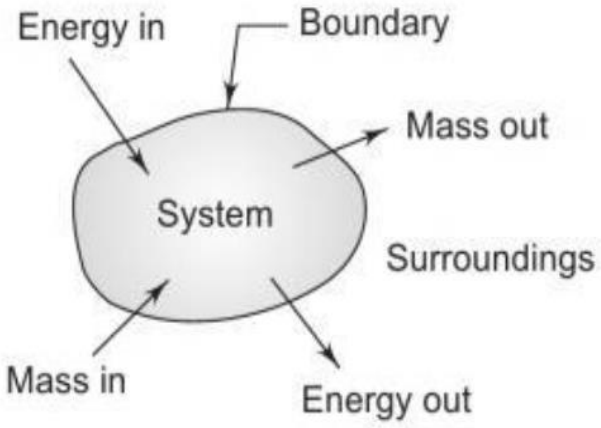
## Control Mass System

- ✓Fixed Mass
- ✓Also called Closed system
- ✓Energy transfer allowed
- ✓Mass Transfer not allowed



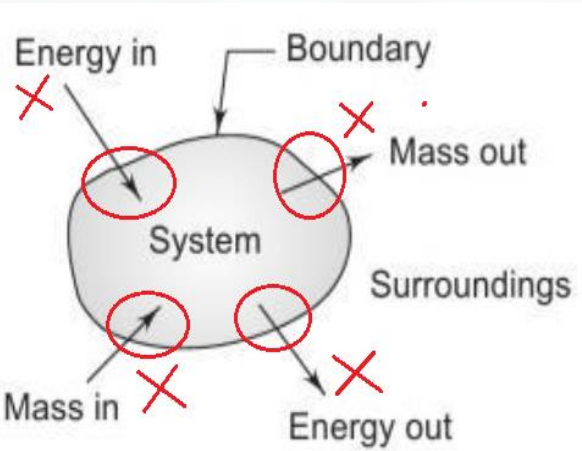

## Control Volume System

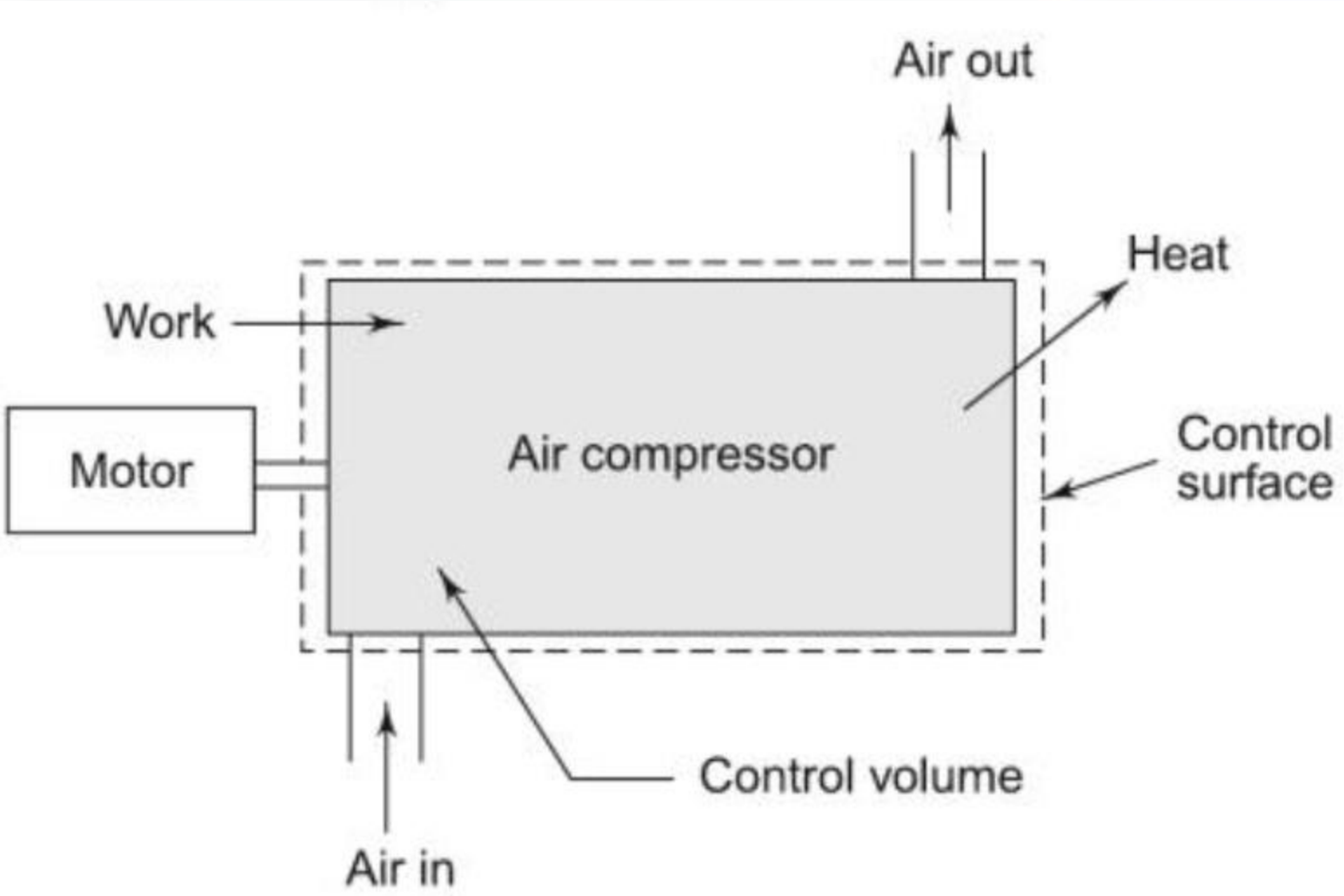
- ✓Fixed Volume
- ✓Also called Open system
- ✓Energy transfer allowed
- ✓Mass Transfer also allowed
- ✓Mass may or may not be fixed




## Isolated System

- ✓Fixed Mass
- ✓Fixed Energy
- ✓Energy transfer not allowed
- ✓Mass Transfer not allowed




Air out
Heat
Work
Motor
Air compressor
Control surface
Control volume
Air in

# Thermodynamic View Point

## Macroscopic (Classical)

Matter is considered as continuous function of space variables

Concerned with effect of action of many molecules and perceived by human senses.

## Microscopic (Statistical)

Attention is Focused on each individual molecule.

System behaviour is described by summing up the behaviour of each molecule.

e.g. Space Applications

Concept of Continuum

*All the results of classical can, however, be derived from the microscopic and statistical study of matter*

# Concept of Continuum

✓A kind of idealization of the continuous distribution of matter.

✓The properties of matter are considered as continuous function of space variables.

✓Property should remain same at each & every point in the system.

Validity parameter is molecular density, i.e. the distance b/w molecules

*Characterised by* → $\lambda$ (Mean free path)

$$Kn = \frac{\lambda}{L}$$

***{ For Kn> 0.01}***
Concept of Continuum holds good

Where ;
Kn : Knudsen Number, dimensionless parameter
λ : Mean free path
L : Characteristic length (Volume/Surface Area)

# Thermodynamic Properties

(Characteristics of system by which its physical conditions may be described)

(e.g. Volume, Temperature, Pressure, Enthalpy, Entropy, Density, Mass etc)

## Intensive Properties

- ✓Whose value independent from extent i.e. mass of system
- ✓e.g. Temp.(T), Pressure (P), density (ρ)

## Extensive Properties

- ✓Whose value depends on extent i.e. mass of system
- ✓Denoted by uppercase letters
- ✓e.g. Volume(V), Enthalpy (H)

## Specific Properties

$$Specific = \frac{Extensive}{Mass}$$

- ✓Special case of intensive property
- ✓Denoted by lowercase letters
- ✓e.g. sp. Vol.(v), sp. enthalpy (h), sp. Internal energy (u)

# Intensive Properties

Boiling Point

Color

Temperature

Luster

Hardness

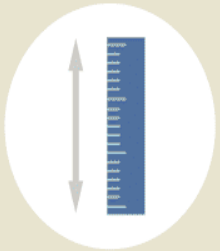
# Extensive Properties

Volume


Mass

Size

Weight



Length

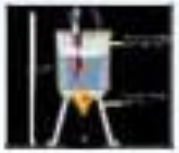
# Intensive properties of matter

Types of intensive properties :


Colour


Odour


Luster

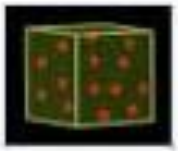

Melting and Boiling point


Specific heat capacity

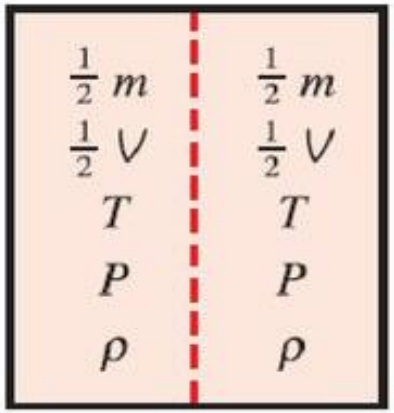

Malleability


Ductility


Conductivity


Density


Pressure

Shape –

Colour –

Weight –

Taste –

Density-

Touch –

Shine –

Volume –

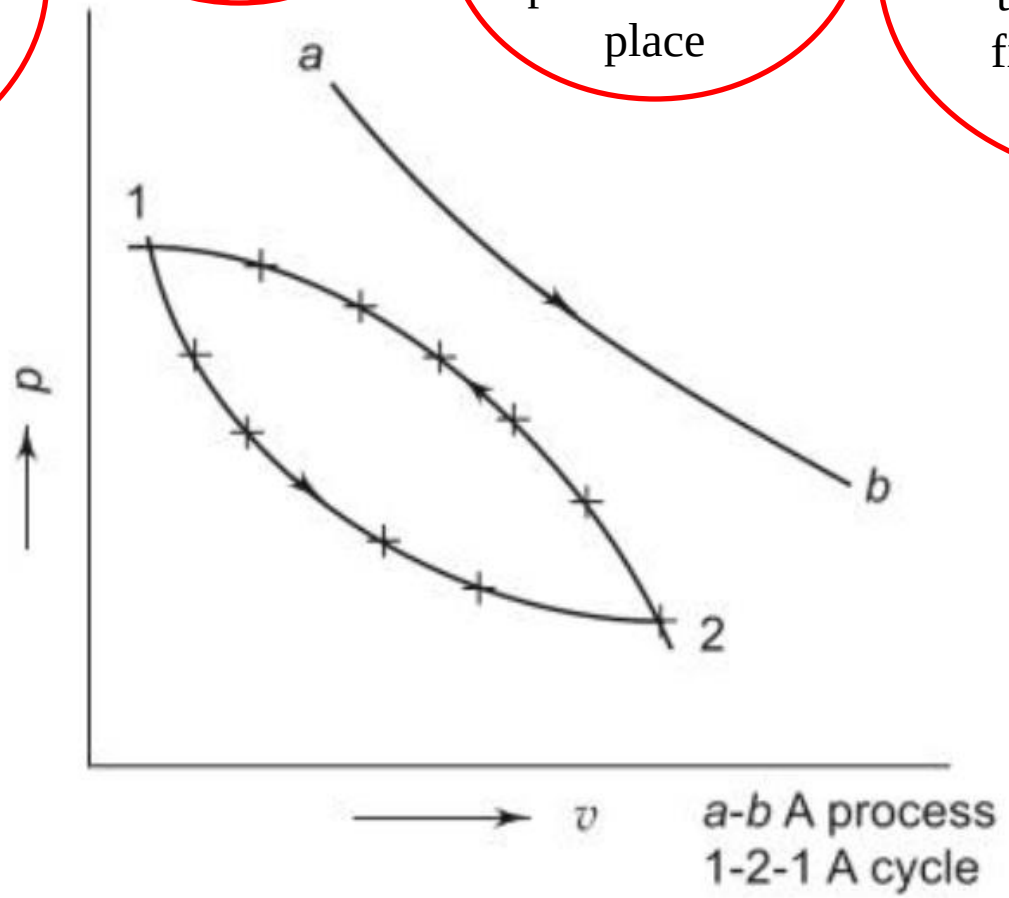
# State, Process, Path & Cycle

When all the properties have definite values, system said to exist at a definite state

Change in state

Locus of points via which process takes place

Series of two or more processes in such manner that initial and final points are identical



# Thermodynamic Equlibrium

## Chemical Equilibrium

- ✓No Chemical Reaction
- ✓No mass Transfer

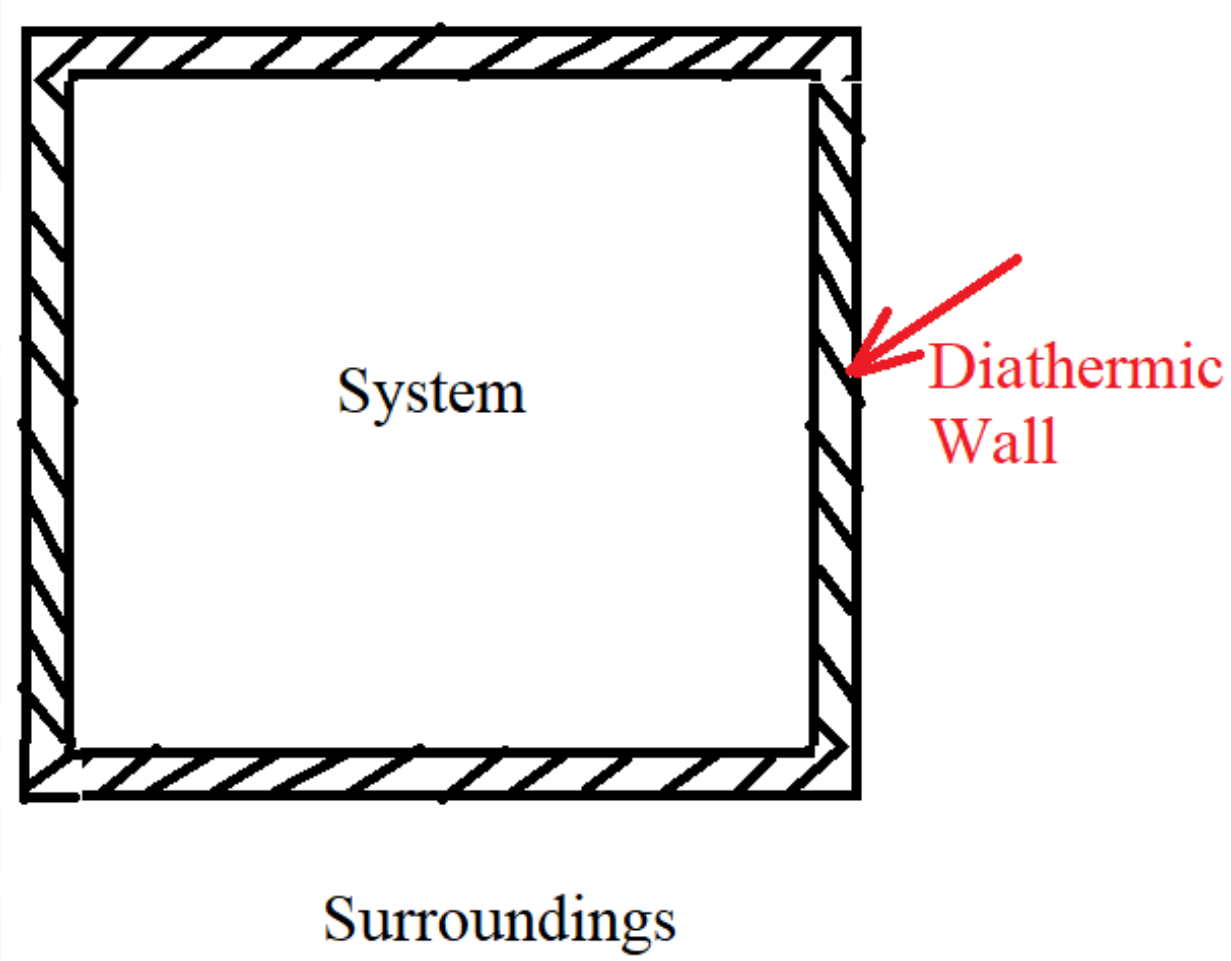
## Mechanical Equilibrium

- ✓No Unbalance force
- ✓No Unbalancing moment
- ✓No Pressure Difference

## Thermal Equilibrium

- ✓No Heat Transfer
- ✓No Change in Properties

Between System and its Surrounding




*Diathermic wall : Allows heat transfer

*Adiabatics Wall : Prevents heat transfer

# Discussion…
# &
# Questions ???