JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTER

Year & Sem. – I Year & I SEM

Subject –Basic Mechanical Engineering (1FY3-07)

Unit– 1

Presented by – Dilip kumar Prajapati (Assistant Professor)

VISION AND MISSION OF INSTITUTE

VISION OF INSTITUTE

To became a renowned centre of outcome based learning and work towards academic professional ,cultur al and social enrichment of the lives of individuals and communities .

MISSION OF INSTITUTE

Focus on evaluation of learning ,outcomes and motivate students to research aptitude by project based learning.

- Identify based on informed perception of Indian ,regional and global needs ,the area of focus and prov ide platform to gain knowledge and solutions.
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- Offer opportunities for interaction between academic and industry .
- Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted lea ders may emerge.

VISION AND MISSION OF DEPARTMENT

Vision

The Mechanical Engineering Department strives to be recognized globally for excellent technical knowledge and to produce quality human resource, who can manage the advance technologies and contribute to society through entrepreneurship and leadership.

Mission

1) To impart highest quality technical knowledge to the learners to make them globally competitive mechanical engineers.
2) To provide the learners ethical guidelines along with excellent academic environment for a long productive career.
3) To promote industry-institute linkage.

Course Outcomes of BME

- To describe the importance of mechanical engineering in any industry and to apply the various concepts in thermal based industry.
- To understand the various machines and power transmission related to it and also the effect of parameters on a job.
- To relate the industrial issues with the environment and to consider key concepts in in engineeri ng materials.
- To come across new practices and researches going in mechanical engineering line CAD, CAM etc.

Contents of UNIT-1

- Introduction to mechanical engineering.
- Concepts of thermal engineering.
- Mechanical machine design.
- Industrial engineering.
- Manufacturing technology.

Introduction to mechanical engineering

- **Mechanical engineering** is an engineering branch that combines engineering physics and mathematics principles with materials science to design, analyze, manufacture, and maintain mechanical systems.

- The mechanical engineering field requires an understanding of core areas including mechanics, dynamics, thermodynamics, materials science, structural analysis, and electricity.

- In addition to these core principles, mechanical engineers use tools such as computer-aided design (CAD), computer-aided manufacturing (CAM), and product lifecycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices, weapons, and others.

Concepts of thermal Engineering

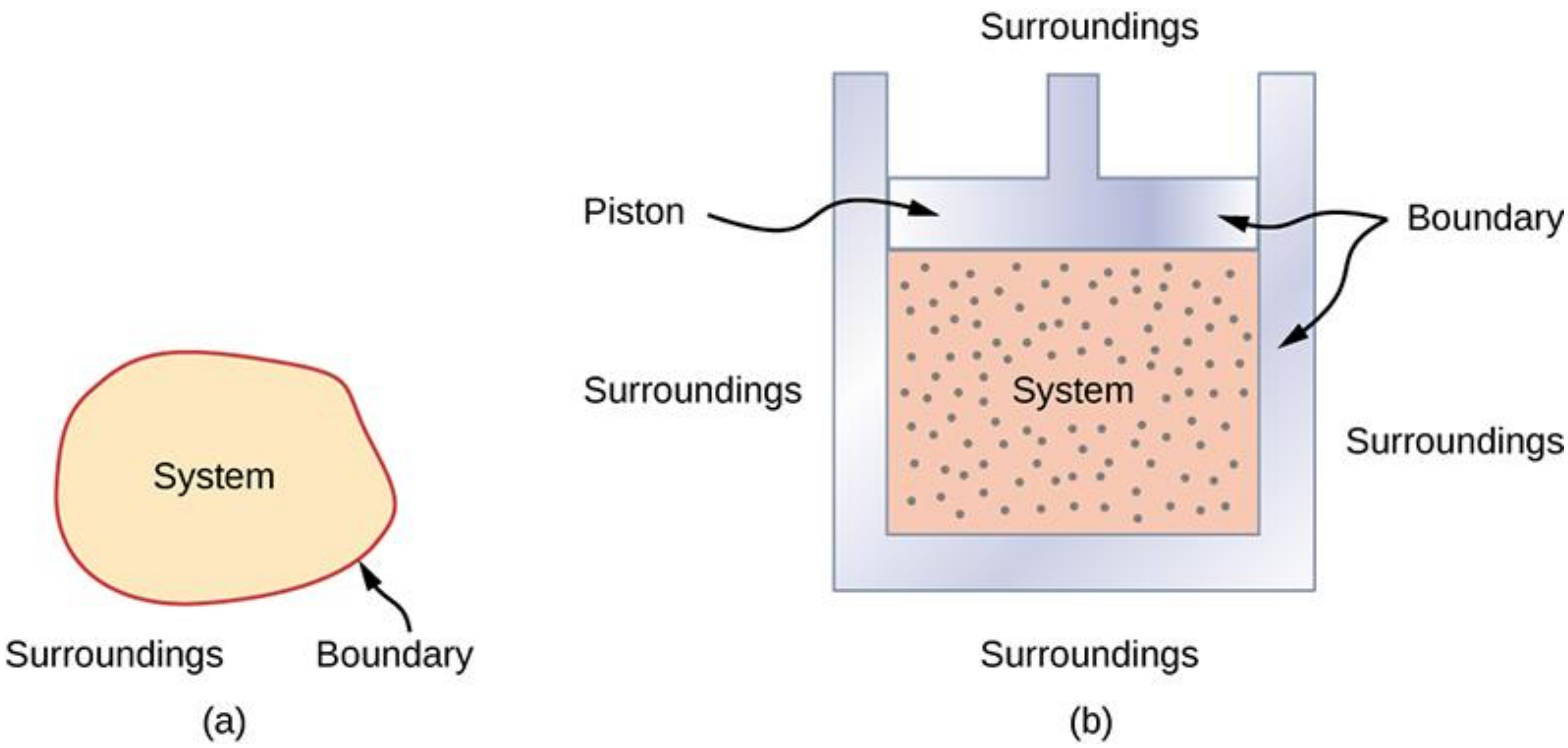
- **THERMODYNAMICS:** It is the science of the relations between heat, Work and the properties of the systems.

- In our study of thermodynamics, we will choose a small part of the universe to which we will apply the laws of thermodynamics. We call this subset a SYSTEM.

- The system is a macroscopically identifiable collection of matter on which we focus our attention (eg: the water kettle or the aircraft engine).

- The rest of the universe outside the system close enough to the system to have some perceptible effect on the system is called the surroundings.

- The surfaces which separates the system from the surroundings are called the boundaries as shown in fig below (e.g: walls of the kettle, the housing of the engine)


System
Surroundings
Boundary
(a)
Surroundings
Piston
Boundary
Surroundings
System
Surroundings
Surroundings
(b)

Types of system

- **Closed system** - in which no mass is permitted to cross the system boundary i.e. we would always consider a system of constant mass. We do permit heat and work to enter or leave but not mass. system Boundary Heat/work in Heat/work Out No mass entry or exit.
- **Open system-** in which we permit mass to cross the system boundary in either direction (from the system to surroundings or vice versa). In analysing open systems, we typically look at a specified region of space, and observe what happens at the boundaries of that region.
- **Isolated System** - in which there is no interaction between system and the surroundings. It is of fixed mass and energy, and hence there is no mass and energy transfer across the system boundary.

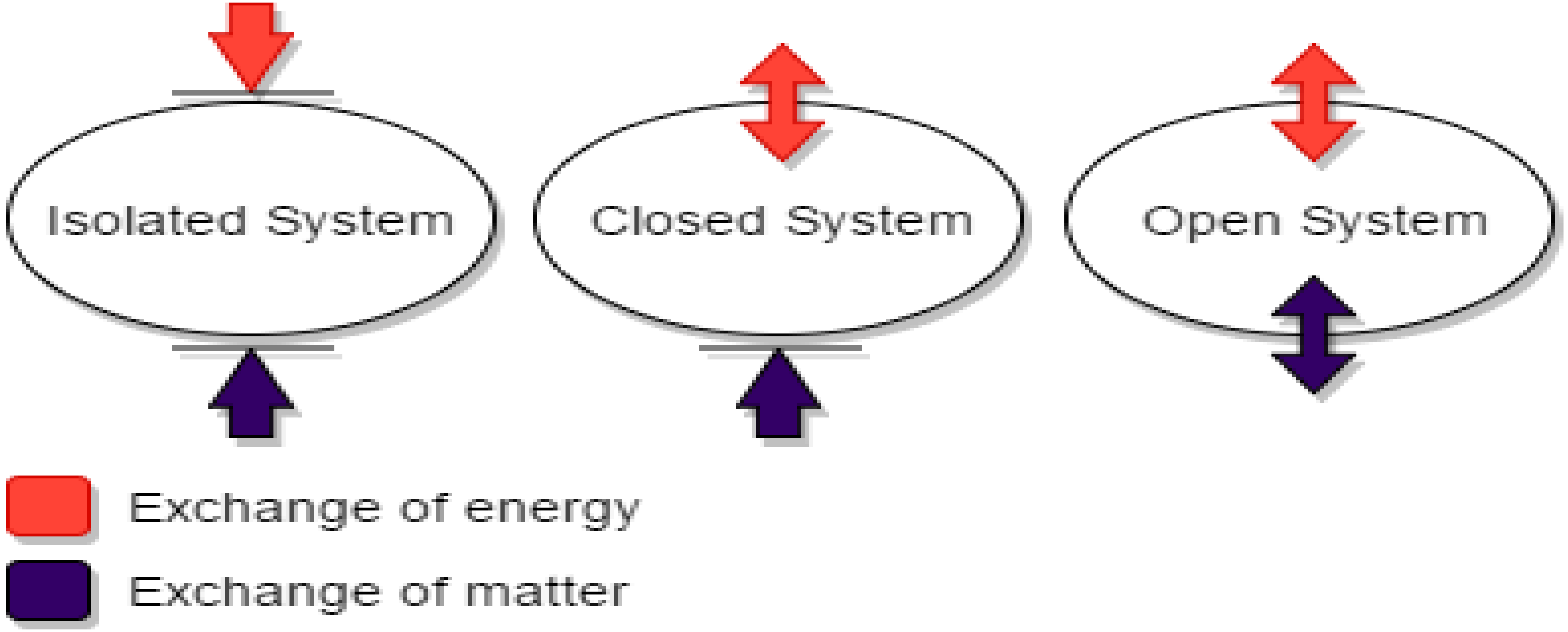


Fig- Closed System, Open System and Isolated System

Macroscopic and Microscopic Approaches

- **In macroscopic approach**, certain quantity of matter is considered, without a concern on the events occurring at the molecular level. These effects can be perceived by human senses or measured by instruments. (e.g.: pressure, temperature)

- **In microscopic approach**, the effect of molecular motion is Considered.

e.g. At microscopic level the pressure of a gas is not constant, the temperature of a gas is a function of the velocity of molecules.

Most microscopic properties cannot be measured with common instruments nor can be perceived by human senses.

Property

- It is some characteristic of the system to which some physically meaningful numbers can be assigned without knowing the history behind it.
- These are macroscopic in nature.
- Invariably the properties must enable us to identify the system.
- eg: Anand weighs 72 kg and is 1.75 m tall. We are not concerned how he got to that stage. We are not interested what he ate!!.

Categories of Properties

- **Extensive property:** whose value depends on the size or extent of the system (upper case letters as the symbols). eg: Volume, Mass (V,M). If mass is increased, the value of extensive property also increases.
- **Intensive property :** whose value is independent of the size or extent of the system. eg: pressure, temperature (p, T).

- **Specific property:** It is the value of an extensive property per unit mass of system. (lower case letters as symbols) eg: specific volume, density (v, ρ).

It is a special case of an intensive property.

Most widely referred properties in thermodynamics: Pressure; Volume; Temperature; Entropy; Enthalpy; Internal energy.

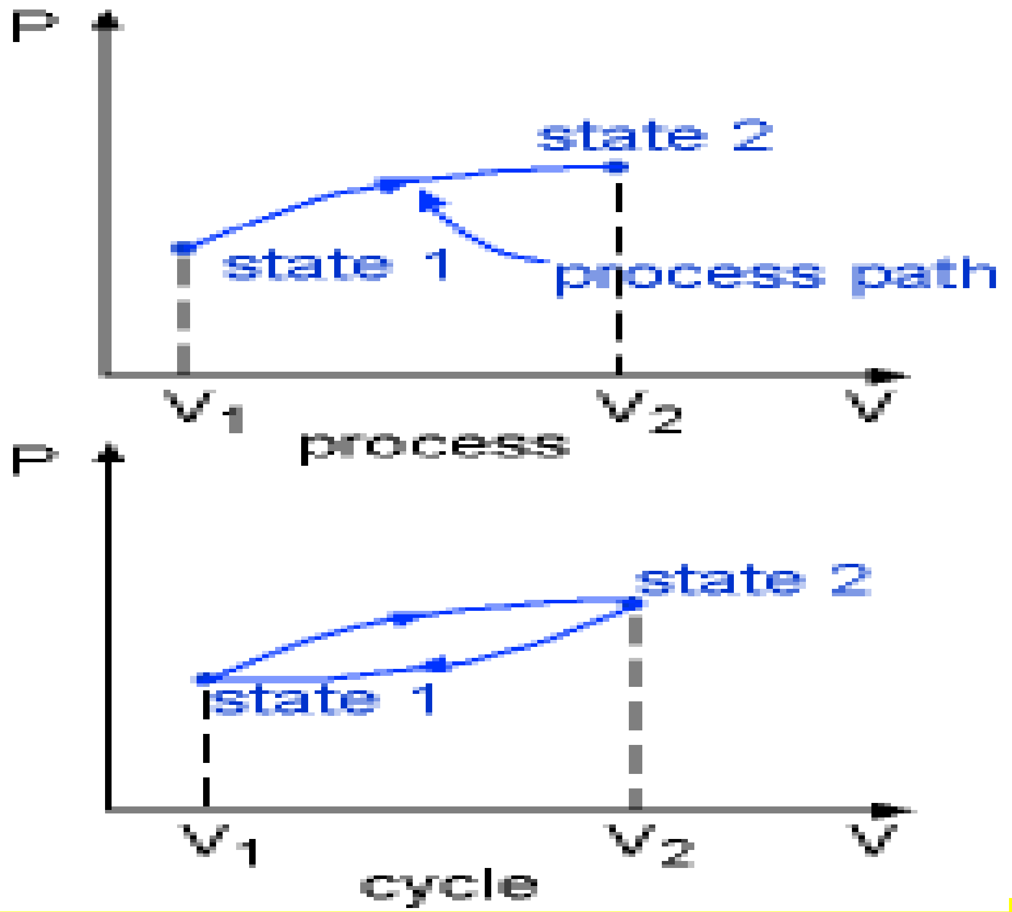
State: It is the condition of a system as defined by the values of all its properties. It gives a complete description of the system. Any operation in which one or more properties of a system change is called a change of state.

Phase: It is a quantity of mass that is homogeneous throughout in chemical composition and physical structure. e.g. solid, liquid, vapour, gas. Phase consisting of more than one phase is known as heterogenous system .

Path And Process

The succession of states passed through during a change of state is called the path of the system. A system is said to go through a process, if it goes through a series of changes in state. Consequently:

- A system may undergo changes in some or all of its properties.
- A process can be construed to be the locus of changes of state.
- Processes in thermodynamics are like streets in a city. eg: we have north to south; east to west; roundabouts; crescents.



Types of Processes

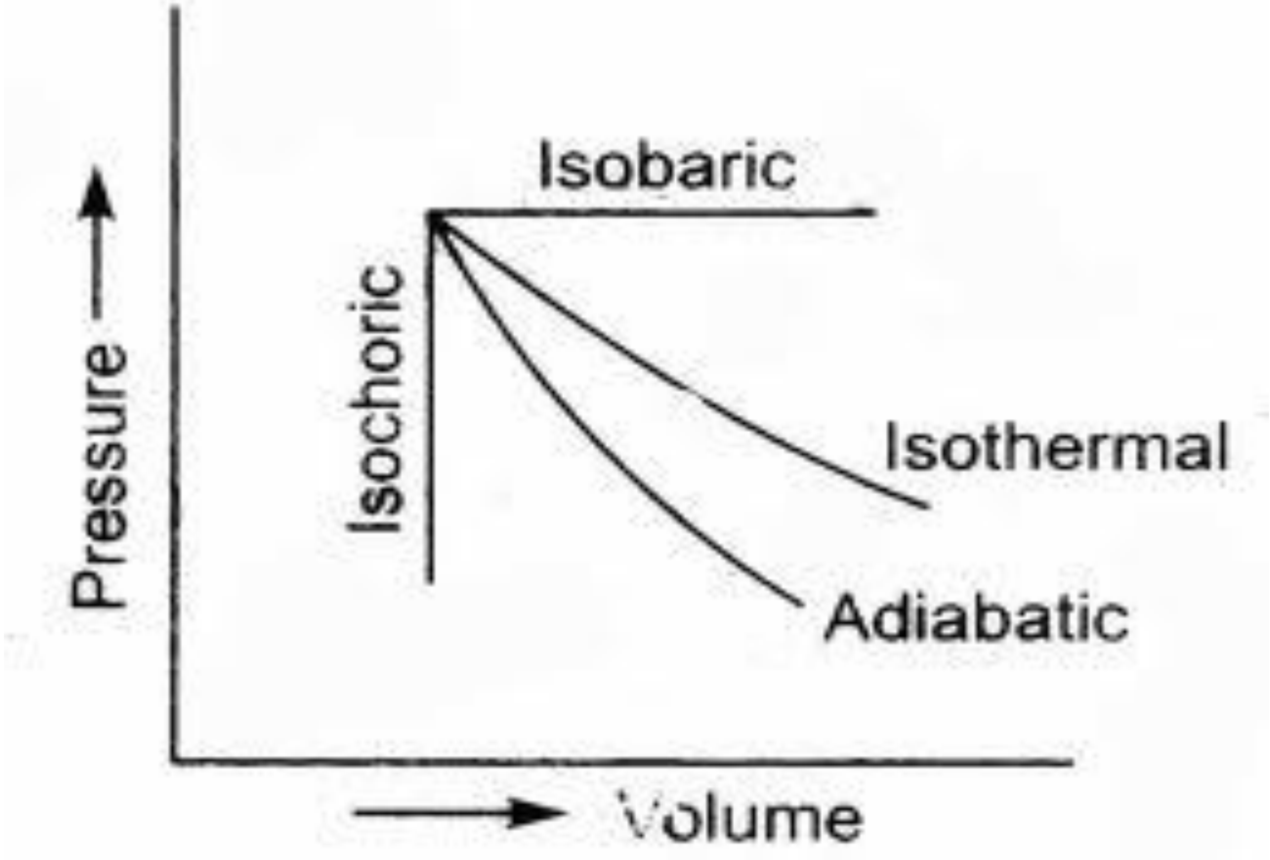
➢As a matter of rule we allow one of the properties to remain a constant during a process.

➢Construe as many processes as we can (with a different property kept constant during each of them).

➢Complete the cycle by regaining the initial state.

There are following processes used in thermodynamics

- Isothermal (T)
- Isobaric (p)
- Isochoric (v)
- Isentropic (s)
- Isenthalpic (h)
- Isosteric (concentration)
- Adiabatic (no heat addition or removal



Quasi-static Processes

A quasi-static process is one in which

- The deviation from thermodynamic equilibrium is infinitesimal.
- All states of the system passes through are equilibrium states.
- If we remove the weights slowly one by one the pressure of the gas will displace th e piston gradually. It is quasistatic.
- On the other hand if we remove all the weights at once the piston will be kicked up by the gas pressure.(This is unrestrained expansion) but we don’t consider that the work is done - because it is not in a sustained manner
- In both cases the systems have undergone a change of state.
- Another eg: if a person climbs down a ladder from roof to ground, it is a quasistatic process. On the other hand if he jumps then it is not a quasistatic process.

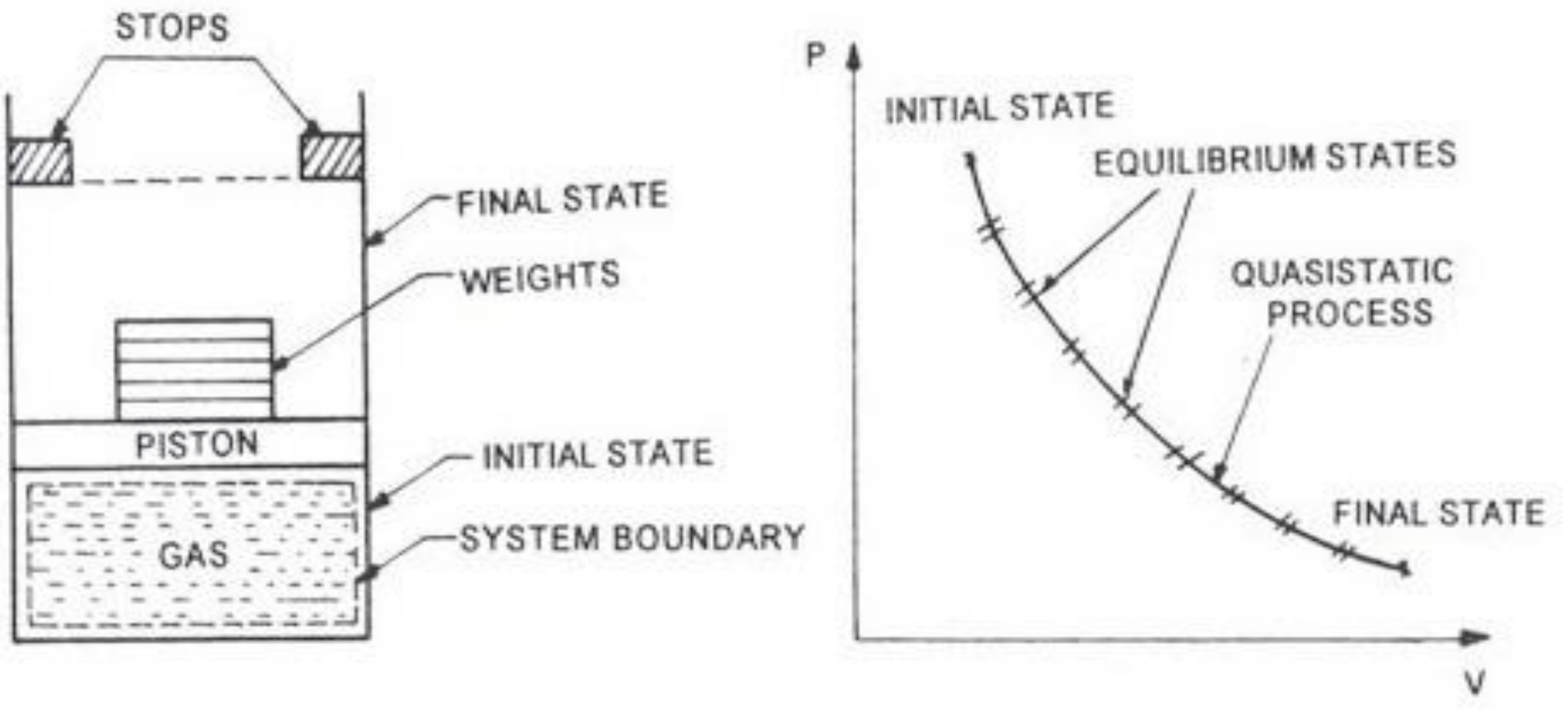


Fig. Quasistatic Process

Equilibrium State

- A system is said to be in an equilibrium state if its properties will not change without some perceivable effect in the surroundings.
- Equilibrium generally requires all properties to be uniform throughout the system.
- There are mechanical, thermal, phase, and chemical equilibria.

Thermodynamic equilibrium

For attaining a state of thermodynamic equilibrium, the following three types of equilibrium states must be achieved.

1. **Thermal Equilibrium:** The temperature of the system does not change with time and has same value at all points of the system.

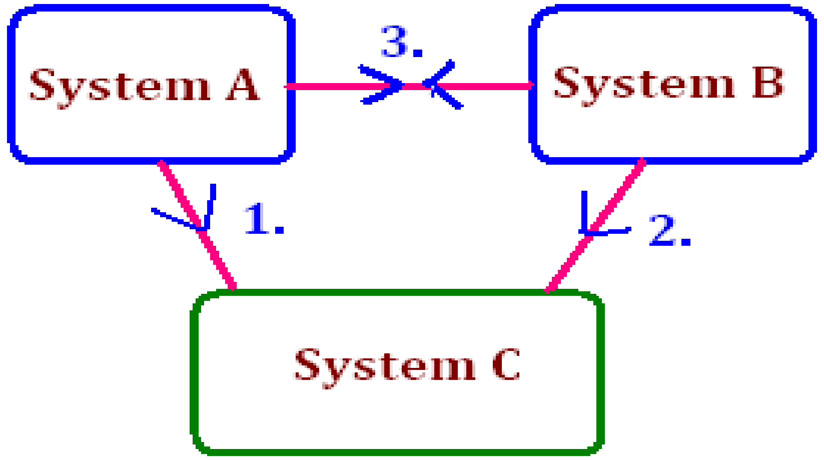
2. **Mechanical Equilibrium:** There are no unbalanced forces within the system or between the surroundings. The pressure in the system is same at all points and does not change with respect to time.

1. **Chemical Equilibrium:** No chemical reaction takes place in the system and the chemical composition which is same throughout the system does not vary with time.

1

Zeroth Law of thermodynamics

- If two systems (say A and B) are in thermal equilibrium with a third system (say C) separately (that is A and C are in thermal equilibrium; B and C are i n thermal equilibrium) then they are in thermal equilibrium themselves (that is A and B will be in thermal equilibrium.
- All temperature measurements are based on this LAW.



1. A & C are in thermal equilibrium
2. B & C are in thermal equilibrium

then

3. A & B are also in thermal equilibrium with each other

Work and Heat

Thermodynamic definition of work: Positive work is done by a system when the sole effect external to the system could be reduced to the rise of a weight.

Thermodynamic definition of heat: It is the energy in transition between the syste m and the surroundings by virtue of the difference in temperature.

All our efforts are oriented towards how to convert heat to work or vice versa:

Heat to work→ Thermal power plant

Work to heat→ Refrigeration

Sign Conventions:

•Work done BY the system is +ve.

•Obviously work done ON the system is –ve.

•Heat given TO the system is +ve.

•Obviously Heat rejected by the system is -ve .

First law of thermodynamics

Statement:

When a closed system executes a complete cycle the sum of heat interactions is equal t o the sum of work interactions.

Mathematically

$\Sigma Q = \Sigma W$

The summations being over the entire cycle

Alternate statement:

When a closed system undergoes a cycle the cyclic integral of heat is equal to the cycl ic integral of work.

Mathematically

$\oint \delta Q = \oint \delta W0$

- HEAT and WORK are not properties because they depend on the path and end states.
- HEAT and WORK are not properties because their net change in a cycle is not zero.

Second Law of Thermodynamics

- The **Kelvin–Planck statement** (or the **Heat Engine Statement**) of the second law of th ermodynamics states that *it is impossible to devise a cyclically operating heat engine, the effect of which is to absorb energy in the form of heat from a single thermal reservoir and to deliver an equivalent amount of work*.

This implies that it is impossible to build a heat engine that has 100% thermal efficiency.

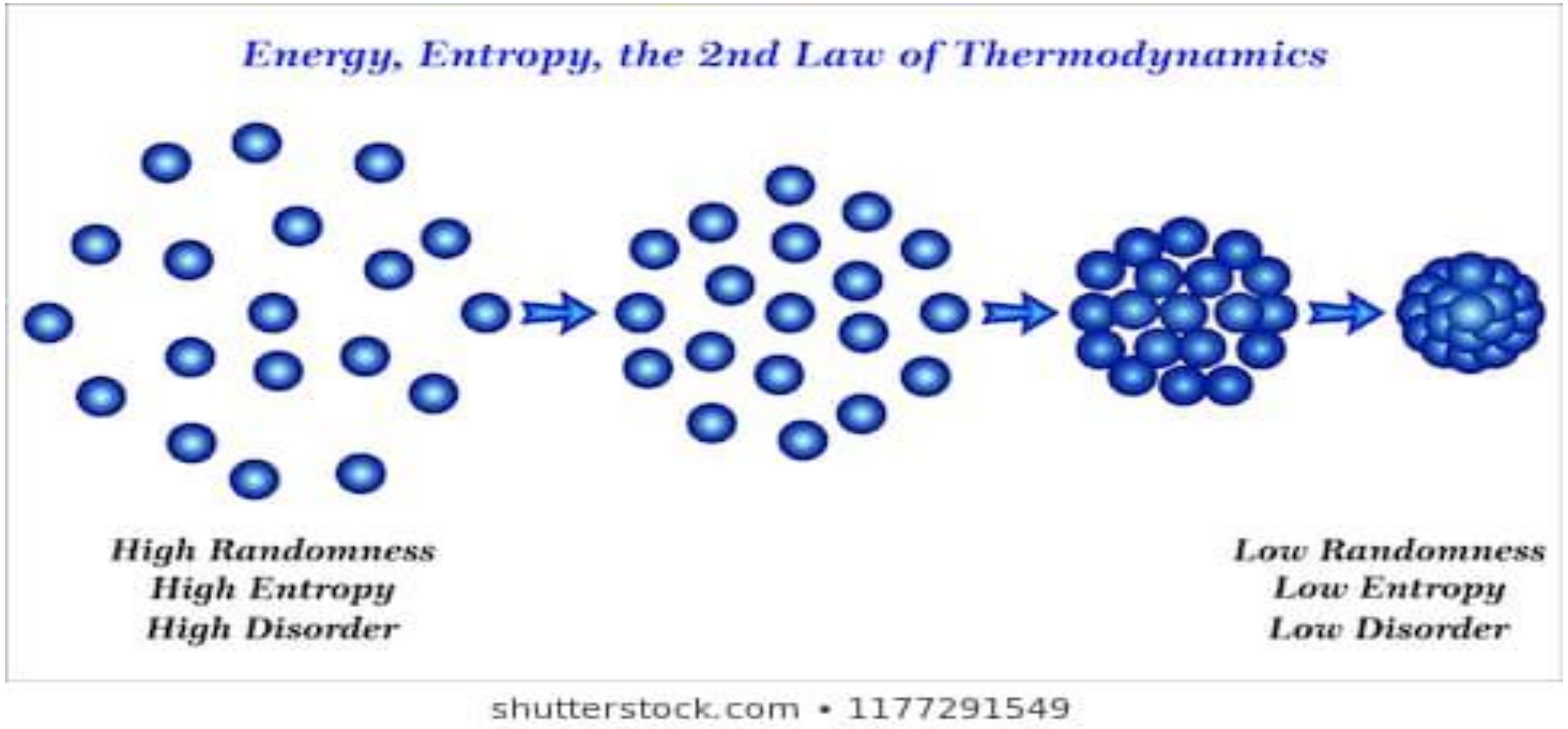
- **Clausius Statement:** It is impossible to construct a device which operates in a cycle an d produces no effect other than the transfer of heat from a cooler body to a hotter body.

Carnot's theorem: Carnot's theorem states that all heat engines between two heat reservoi rs are less efficient than a Carnot heat engine operating between the same reservoirs. Ever y Carnot heat engine between a pair of heat reservoirs is equally efficient, regardless of the working substance employed or the operation details.

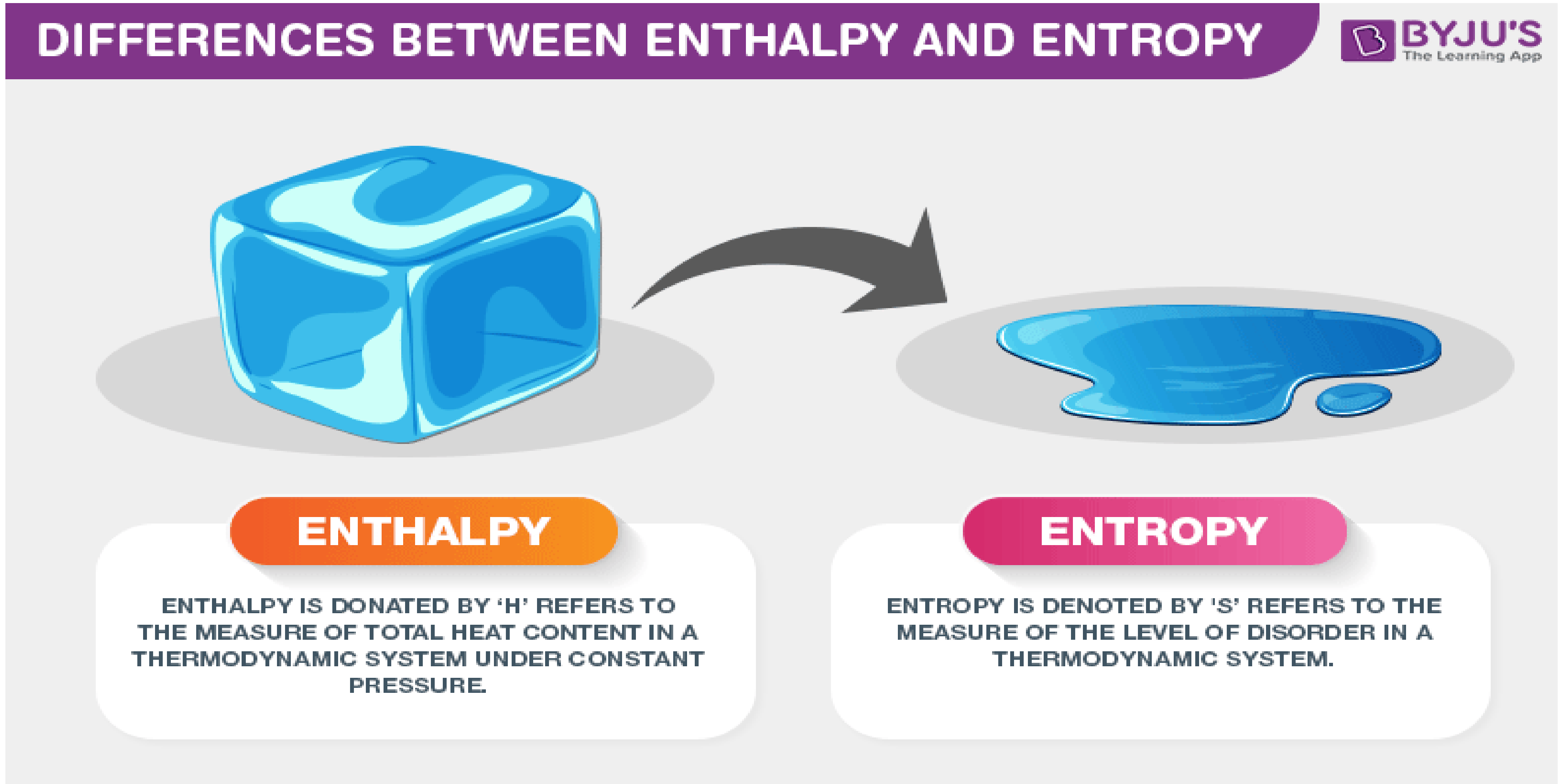
Entropy

➢ **Entropy** is the loss of energy available to do work. Another form of the second law of **thermodynamics** states that the total **entropy** of a system either increases or remains constant; it never decreases.

➢ **Entropy** is zero in a reversible process; it increases in an irreversible process.



Difference Between Enthalpy and Entropy



- Enthalpy is the measure of total heat present in the thermodynamic system where the pressure is constant.

It is represented as $\Delta H=\Delta E+P\Delta V$ where, E is the internal energy.

- Entropy is the measure of disorder in a thermodynamic system. It is represented as $\Delta S=\Delta Q/T$ where, Q is the heat content and T is the temperature.

Mechanical machine design

- Mechanical Design or Machine Design is one of the important branches of Engineering Design.
- To understand what exactly machine design or mechanical design is let us consider the example of the gear box of the car.
- The gear box transmits the motion and the power of the engine to the wheels of the vehicle.
- The gearbox comprises group of gears which are subjected to not only motion but also the load of the vehicle.
- For the gears to run at desired speeds and take desired loads it is important that they should be designed.

The knowledge of machine design helps the designers as follows:

1. To select proper materials and best suited shapes,
2. To calculate the dimensions based on the loads on machines and strength of the material,
3. Specify the manufacturing process for the manufacture of the designed component of the machine or the whole machine.

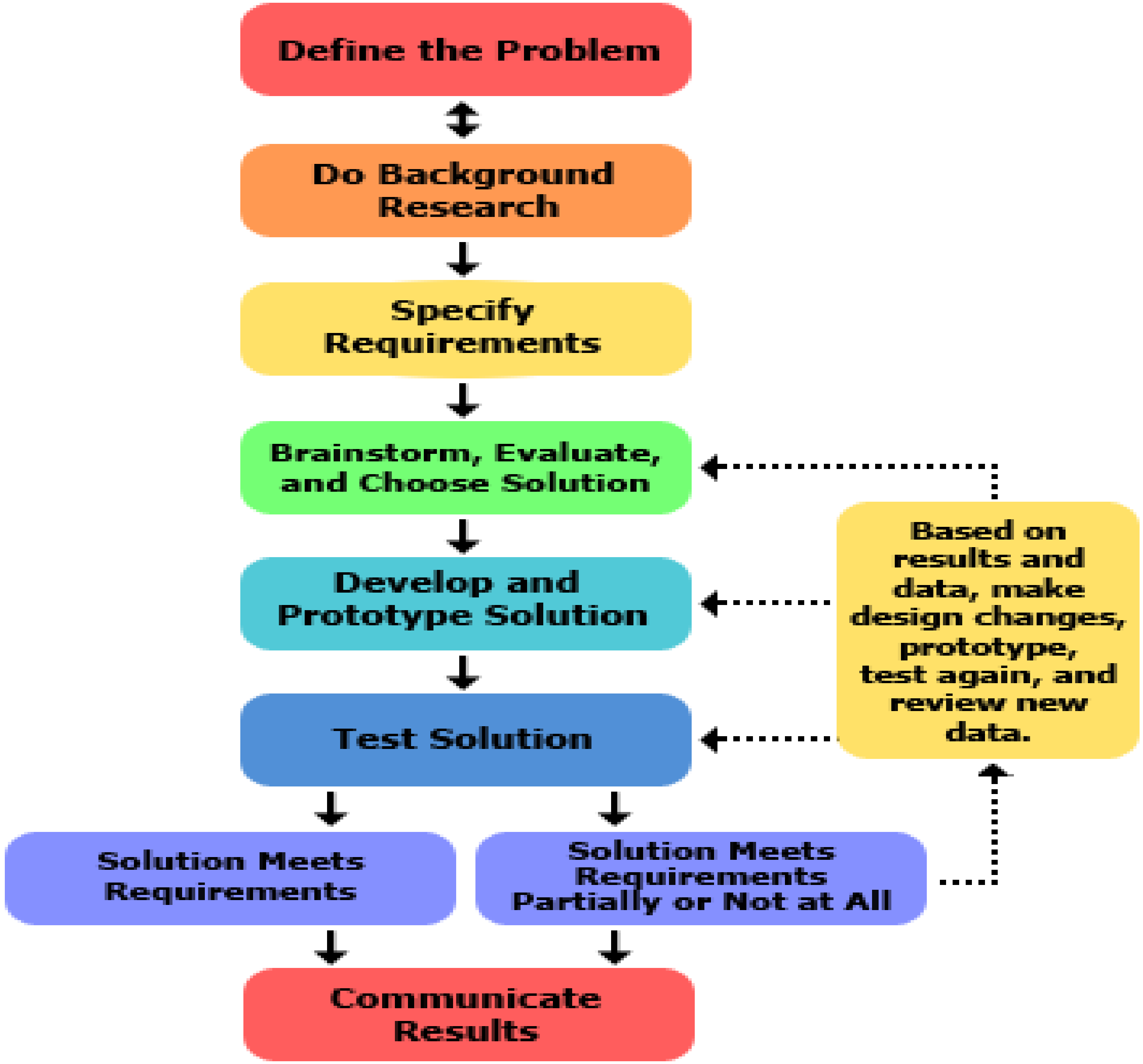


Fig. Steps of Mechanical Engineering Machine Design

Industrial Engineering

- **Industrial engineering** is an engineering profession that is concerned with the optimization of complex processes, systems, or organizations by developing, improving and implementing integrated systems of people, money, knowledge, information, equipment, energy and materials.

- The focus of Industrial Engineering is how to improve processes or design things that are more efficient and waste less money, time, raw resources, man-power and energy while following safety standards and regulations.

- Industrial engineers may use knowledge of Maths, Physics but also Social Sciences to analyse, design, predict and evaluate the results and roadblocks of processes and devices.

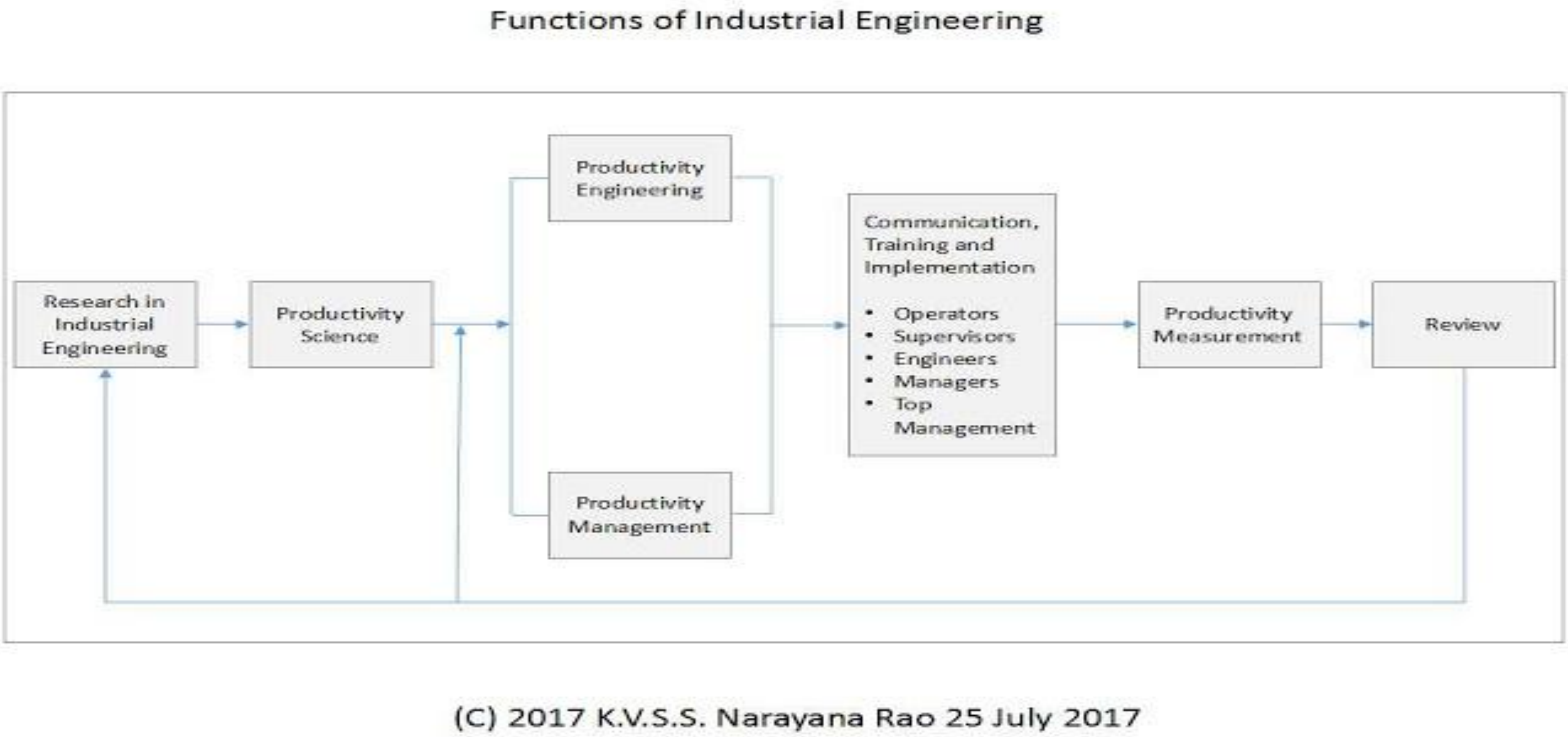


Fig. Function of industrial engineering

Manufacturing technology

- Manufacturing engineering or **manufacturing process** are the steps through which raw materials are transformed into a final product.

- The manufacturing process begins with the product design, and materials specification from which the product is made.

- These materials are then modified through manufacturing processes to become the required part.

- Use of CAD and CAM play an important role in manufacturing technology.

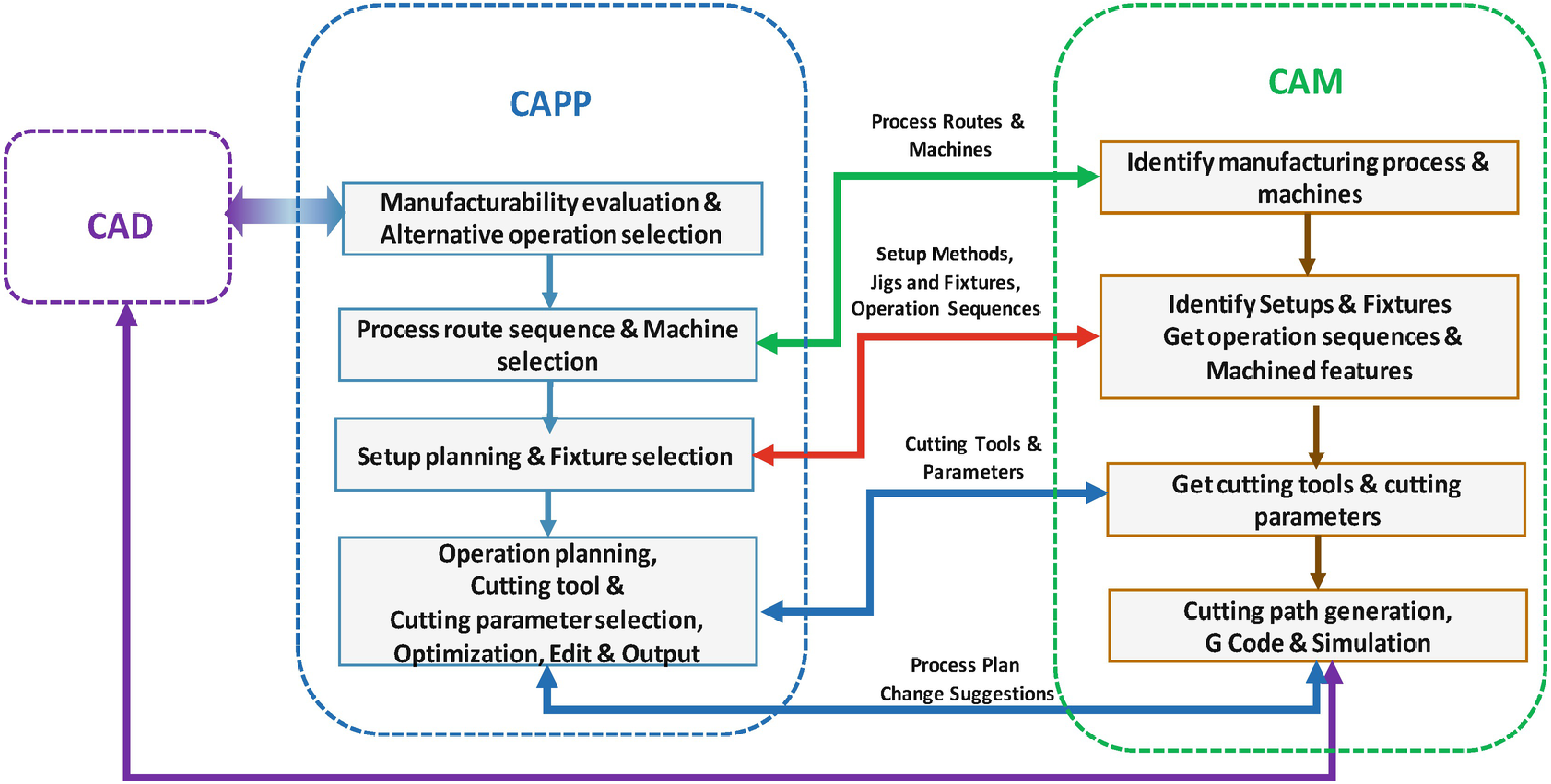


Fig. Use of CAD & CAM in manufacturing technology

COMPUTER AIDED MANUFACTURING (CAM)

- Cam uses NC(numerical controlled) machines and CNC(computer numerical controlled) machines with the help of NC programs and APT programs.
- With the help of these programs we can control the motion of machines such as milling, drilling, cutting etc.
- In NC part programming we have to enter a sequence of instructions and machines work accordingly. For Ex.

  Moo- PROGRAM STOP

  Mo6- TOOL CHANGE

A.N.KHUDAIWALA

Fig. CAM manufacturing technology

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Thank you!

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