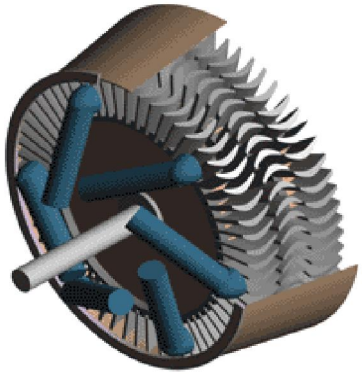
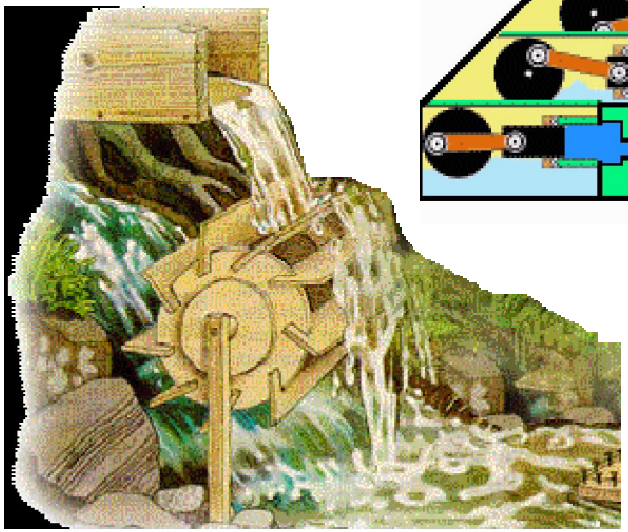
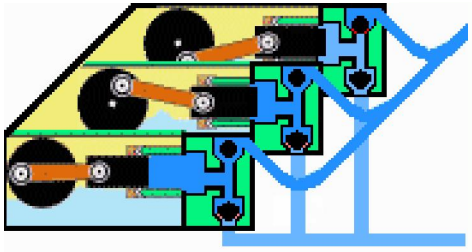
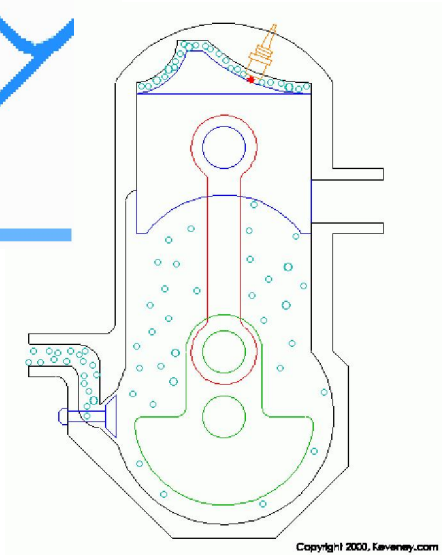
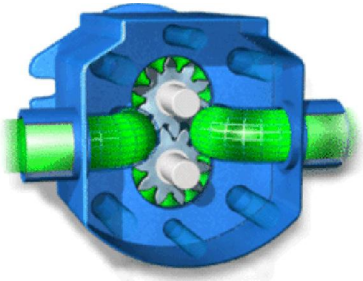
Welcome in a World of Mechanical Engineering

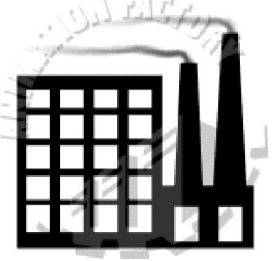












Introduction – Ashish J. Modi

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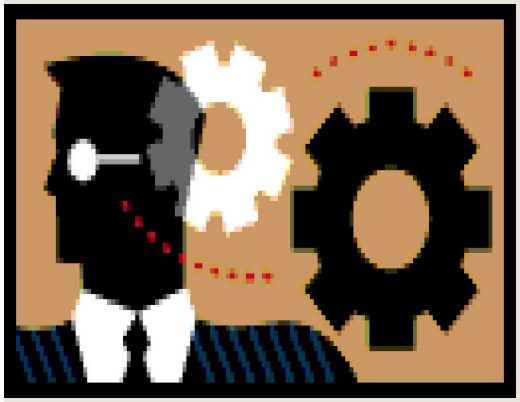
- Email: ashishjmodi@gmail.com
- Website: www.ashishjmodi.yolasite.com

- Education: UG (‘05) & PG (‘07) from MSU, Baroda
- Specialization in Jet Propulsion & Gas Turbine.
- Research Papers: 3 Int. Journal, 4 Int. Conf., 1 Nat. Conf.
- Subject thought-
  - Element of Mechanical Engg. - UG
  - Fluid Power Engineering - UG
  - Fluid Mechanics and Gas Dynamics – UG & PG
  - Computational Fluid Dynamics (CFD) - PG
  - Conventional & Non Conv. Energy Systems - UG

- Membership:
  - ISTE Life Member
  - SAE International
  - JCI Bharuch S’ad Vidya

Elements of Mechanical Engineering



Ashish J. Modi
Assistant Professor
Department of Mechanical Engineering
Shri S'ad Vidya Mandal Institute of Technology,
Bharuch – 392001 (Guj.)

EME content

- Introduction - Lecture
- Fuels and combustion - Lecture
- Properties of gases - Lecture
- Properties of steam - Lecture
- Heat engines - Lecture
- Steam boilers – Lab + Lecture
- I. C. Engines – Lab + Lecture
- Speed control - Lab
- Pumps – Lab + Lecture
- Air compressors – Lab + Lecture
- Refrigeration and A/c – Lab + Lecture
- Couplings, clutches and brakes – Lab + Lecture
- Transmission of motion and power - Lab
- Important engineering materials – Lab or Lecture

EME Lab

1. Study of Different Type of Steam Boilers.
2. Study of Steam Boiler Mounting & Accessories.
3. Study of I.C. Engine.
4. Study of Speed Control of Different Engines.
5. Study of Calorimeter.
6. Study of Pumps.
7. Study of Air Compressor
8. Study of Refrigeration & Air Conditioner.
9. Study of Coupling, Clutches & Breaks.
10. Study of Important Engineering Materials.

EME Lab

- Evaluation:
  - Every week by checking journal, assignments etc.
  - Attendance 75% compulsory for Lab and Lecture both.

Reference Books

- Elements of Mechanical Engineering by Alpesh Mehta
- Elements of Mechanical Engineering by NM Bhatt & J.R. Mehta
- Elements of Mechanical Engineering by BL Singhal and Rahual Singhal
- Elements of Mechanical Engineering by Desai and Soni
- Elements of Mechanical Engineering by S. M. Bhatt et al.
- Elements of Mechanical Engineering by Dr. Sadhu Singh
- Elements of Mechanical Engineering by Dr. Sankhavara

Teaching Scheme

EME
(150 marks)

Lectures – 3hrs. per week.
Laboratory - 2hrs. per week.

Theory
(100 marks)

Practical
(50 marks)

End Sem Exam
(70 marks)

Marks will be evaluated from Viva, Quiz, Assignment, Journal and Attendance.

Mid Sem Exam
(30 marks)

Chapter - 1

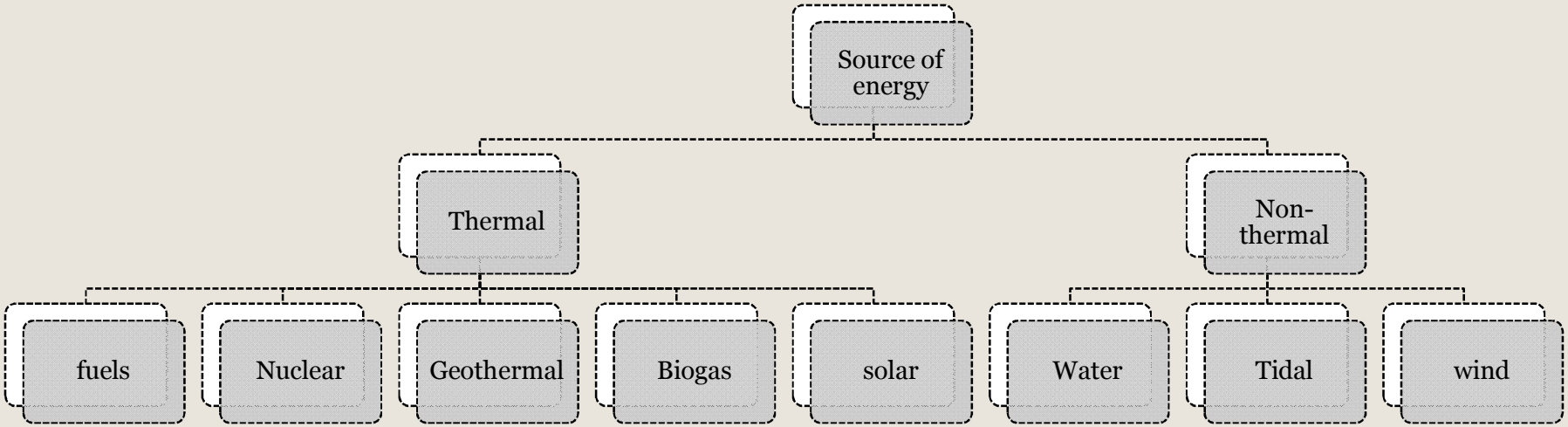
Introduction

Prime movers

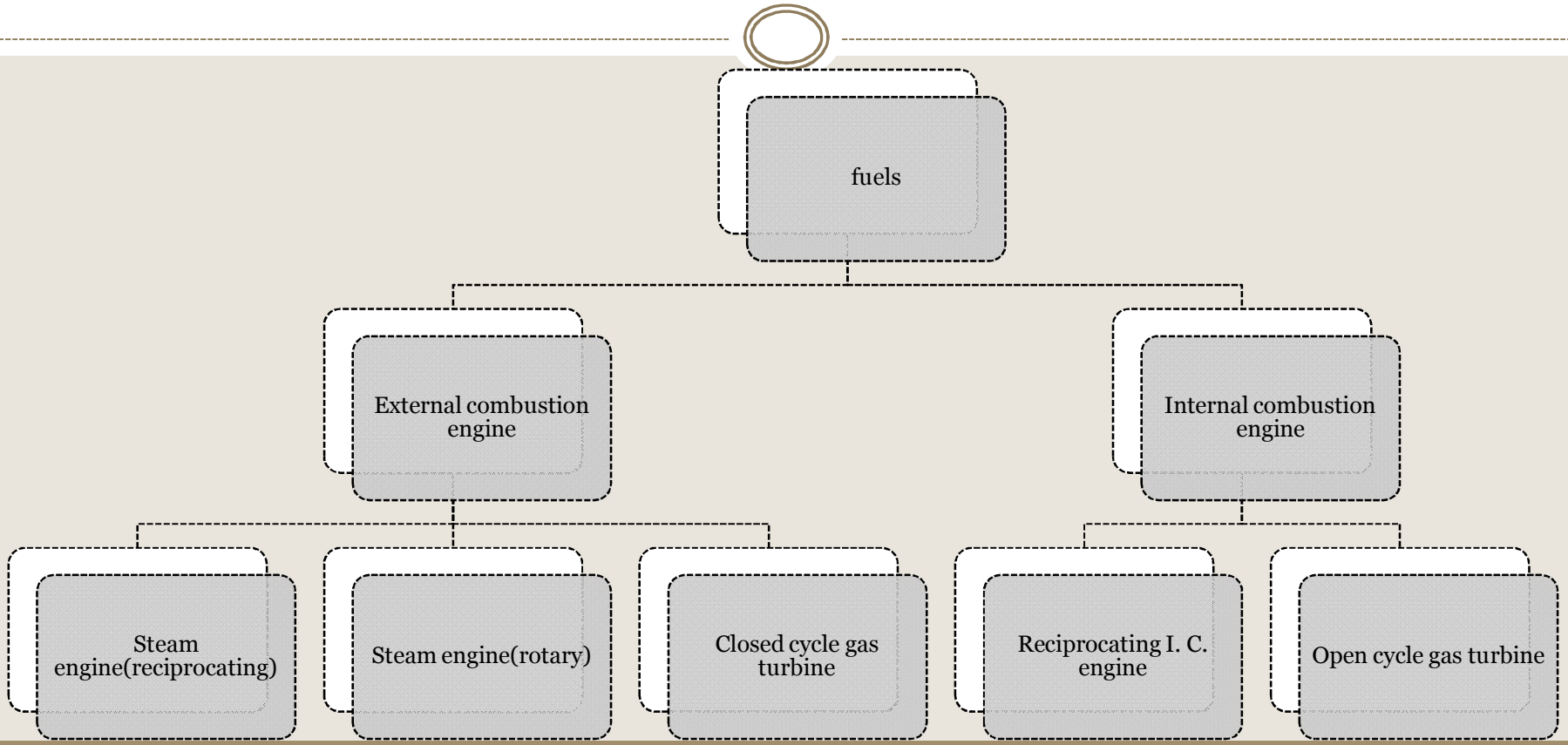
- Definition

  Prime mover is an engine or a device which converts natural source of energy in to mechanical work.

Classification of prime movers



Classification of prime movers



Certain definitions

- Force

  Force is the product of mass and acceleration of the body upon which it is applied.

  unit:-Newton or Kg . m/S^2

  $F = m \times a$ (N)

Certain definitions

- Mass

  Mass is the quantity of matter and it is constant.

  unit:-kg

- Weight

  Weight is the force exerted by gravity.

  $W=m\times g$

Certain definitions

- Pressure

  pressure is defined as normal force per unit area.

  unit:-N/m^2

  P=F/a

  types:-

  gauge pressure

  atmospheric pressure

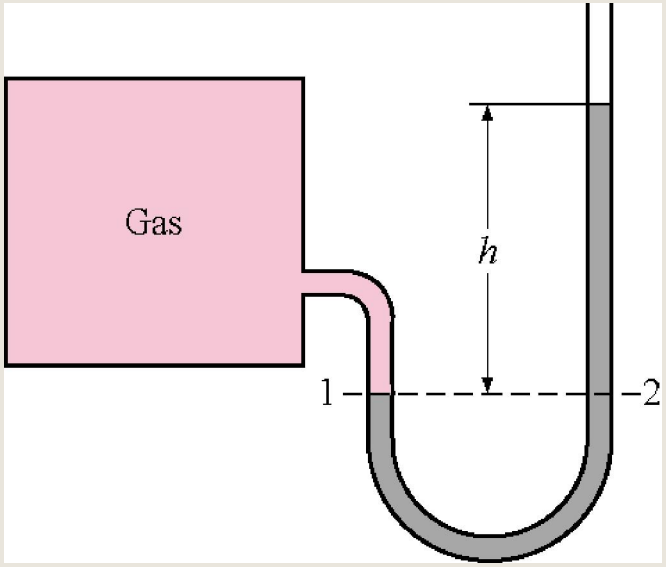
  absolute pressure

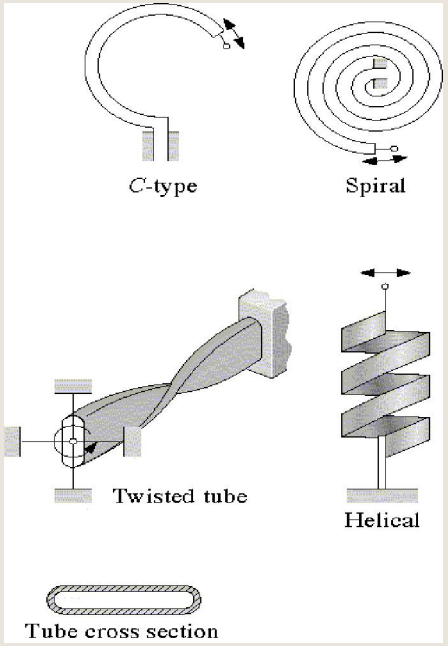
  vacuum pressure

External Link

Pressure Measurement Devices

Simple Manometer





Various types of Bourdon tubes used to measure pressure.

Certain definitions

- Energy

  energy is defined as capacity to exert force through distance

  unit:-Nm

- Power

  rate of energy transfer is known as power.

  OR

  rate of doing work is known as power

  unit:-Nm/s

- Temperature

  it is quantitative measure of degree of hotness or coldness of the system

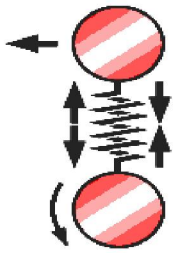
Forms of Energy

- The sum of all forms of energy of a system is called ***Total Energy***, which is considered to consist of internal, kinetic, and potential energies. $E = U + mV^2/2 + mgz$
- ***Internal energy*** represents the molecular energy of a system and may exist in sensible, latent, chemical, and nuclear forms. Represented by symbol, ***U***.
- ***Kinetic Energy*** is the energy that a system possesses as a results of its motion relative to some reference frame. $KE = mV^2/2$
- **Potential Energy** is the energy that a system possesses as a results of its elevation in a gravitational field. $PE = mgz$

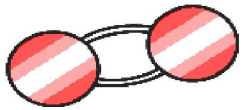
Internal Energy of System

System's Internal Energy =

Sum of Microscopic Energies



SENSIBLE AND LATENT ENERGY



CHEMICAL ENERGY

NUCLEAR ENERGY

Interaction of Energy

- Form of Energy not stored in a system
- Occurred at *System Boundary*
- In the form of *Heat Transfer* or *Work Transfer* or *Mass Transfer*
- For *control mass*, if the *driving force* for the interaction is temperature then the interaction is heat transfer otherwise it is work transfer
- For *control volume* ~ can also involve mass transfer

Thermodynamic Properties

- ***Properties*** are any measurable characteristics of a system. eg. Pressure, temperature, volume, mass and density.

- ***Extensive properties*** are the mass-dependent properties of a system. i.e. the properties that will vary proportionally with mass of the system. E.g. volume

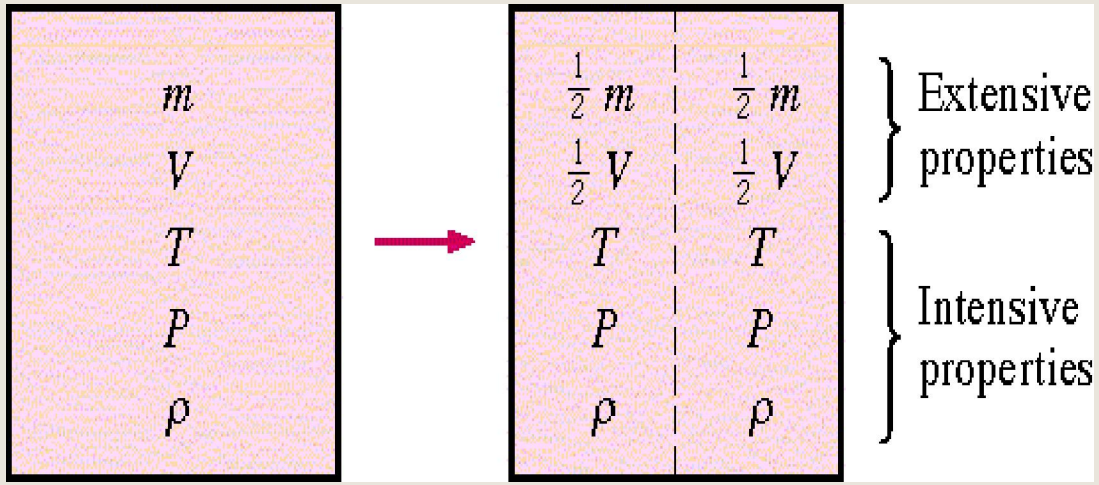
- ***Intensive properties*** are the properties that are not dependent on mass. Eg. Temperature, density. If any ***Extensive Property*** is divided by the mass we would also obtain an intensive property.

Types of properties

- Extensive property

  e.g. specific heat, specific volume, specific enthalpy
- Intensive property

  e.g. mass, volume, energy, enthalpy



Viewpoint to analyze behavior of matter

- Macroscopic viewpoint

  Focus is concentrated on certain quantity of matter

- Microscopic viewpoint

  Events at molecular level is considered

Thermodynamic system and control volume

- System

  It is defined as a quantity of matter or a region in a space upon which attention is focused for the analysis of the problem.

  types

  homogeneous

  heterogeneous

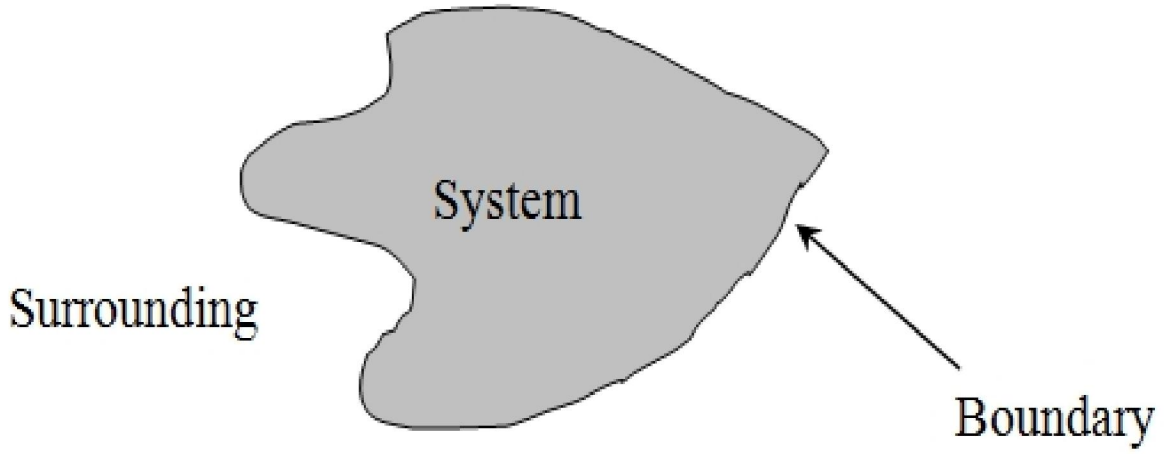
- Surrounding

  Everything external to the system is surrounding.

- Boundary

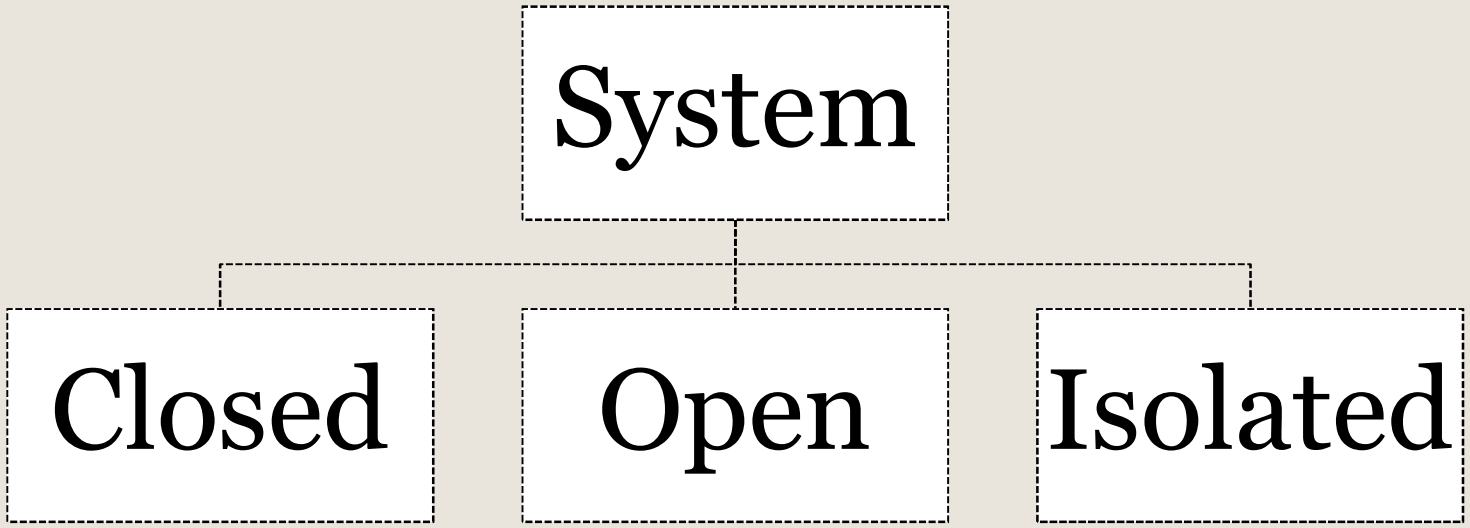
  It is real or imaginary boundary separating system and surrounding. Boundary of a control volume system is called control surface. Mass and energy flow across the control surface.

System



Universe = Thermodynamic System + Surrounding

Thermodynamic system and control volume



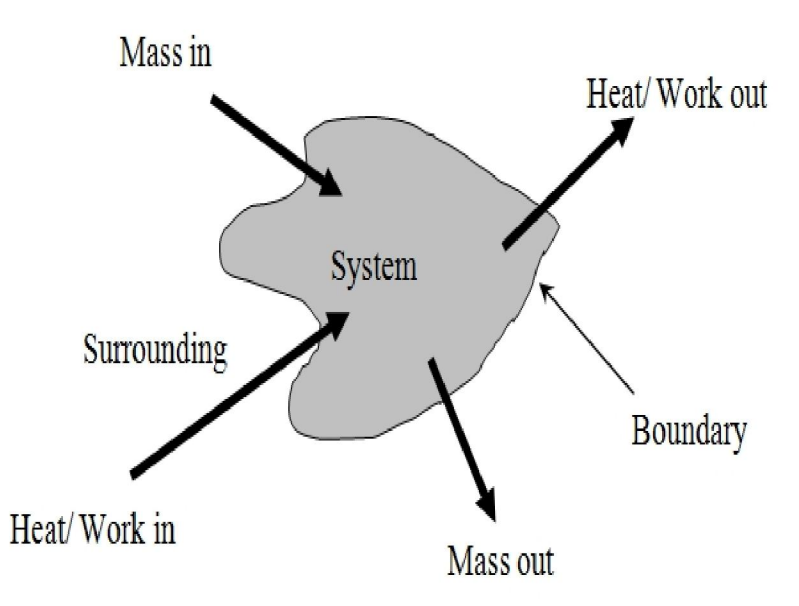
Systems

- Open System: A system, in which both mass and energy in terms of heat and work are permitted to cross the system boundary, is called the closed system.

- Closed System: A system in which no mass is permitted to cross the system boundary but heat and work is permitted to enter or leave, is called the closed system.

- Isolated System: A system, which is not influenced by the surrounding means there is no interaction between system and surrounding, is called isolated system.

Open System



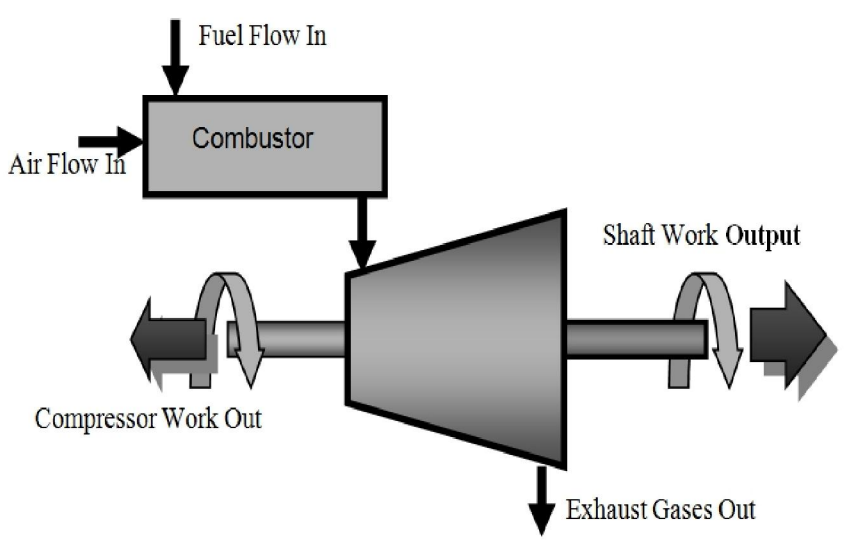
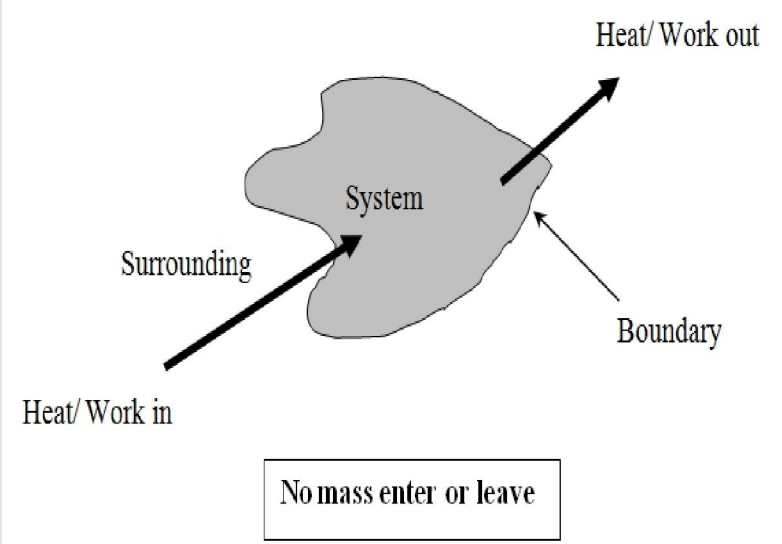


Figure: Gas turbine – an open system

Closed System



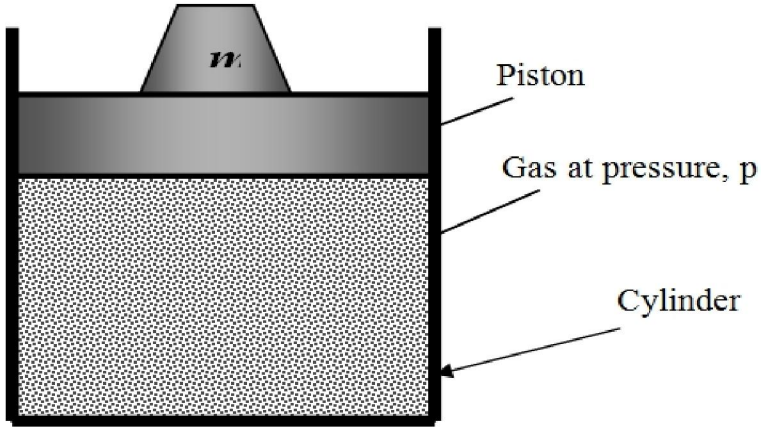
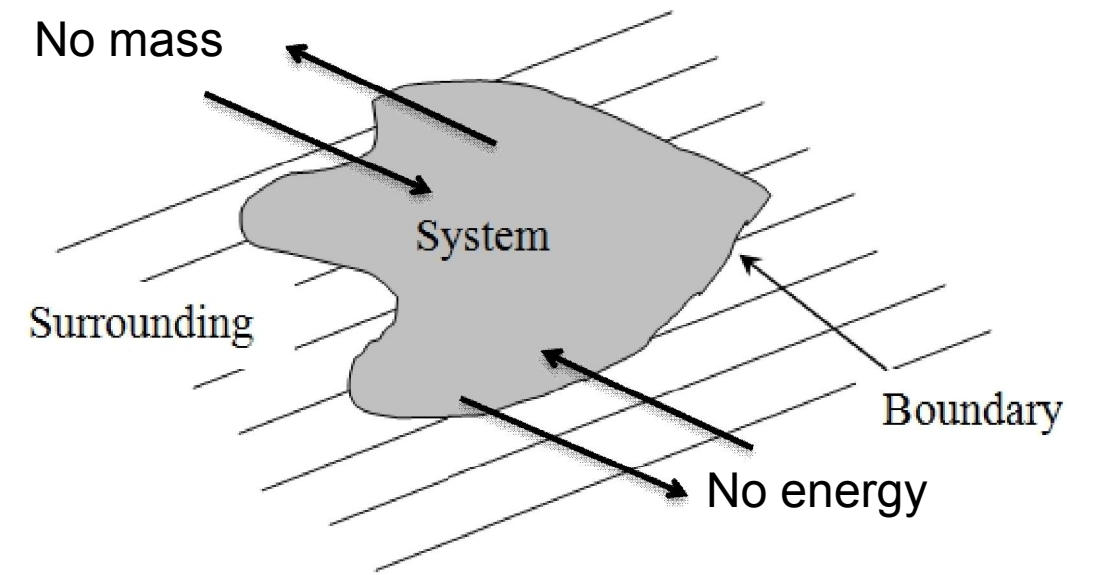


Figure: Compression of a gas in a piston-cylinder Assembly – a closed system

Isolated System



Properties, process and cycle

- Properties

  system have certain characteristics by which its physical condition can be described such as pressure, temperature, etc. these are called properties.
- State

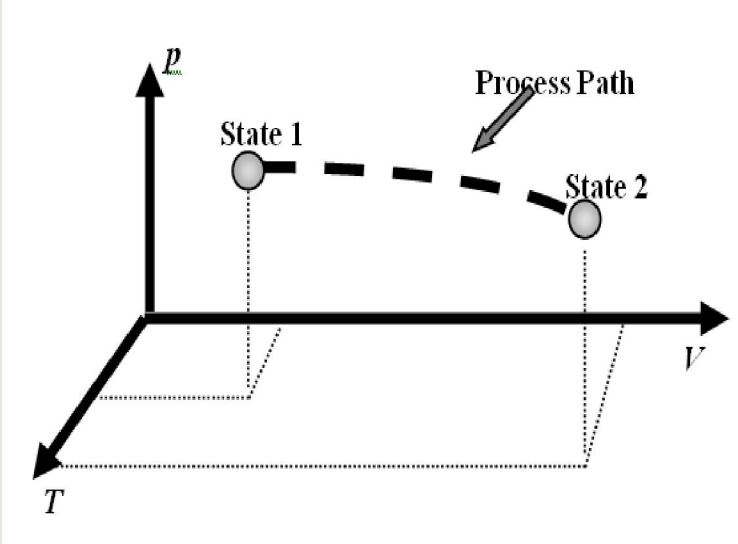
  all system properties having definite values, the system is said to be in definite state. any operation in which one or more properties change is called change of state.
- Path

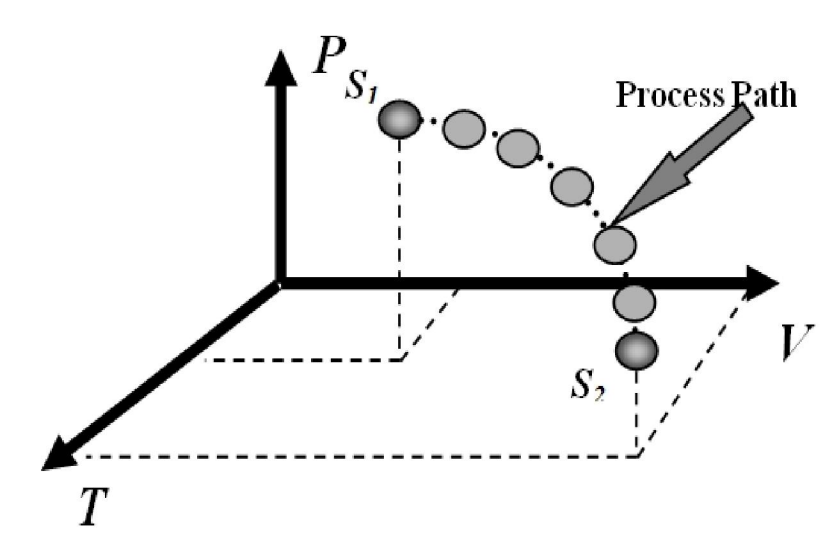
  succession of states passed through change of state is called path
- Process

  if path is completely specified it is called process
- Cycle

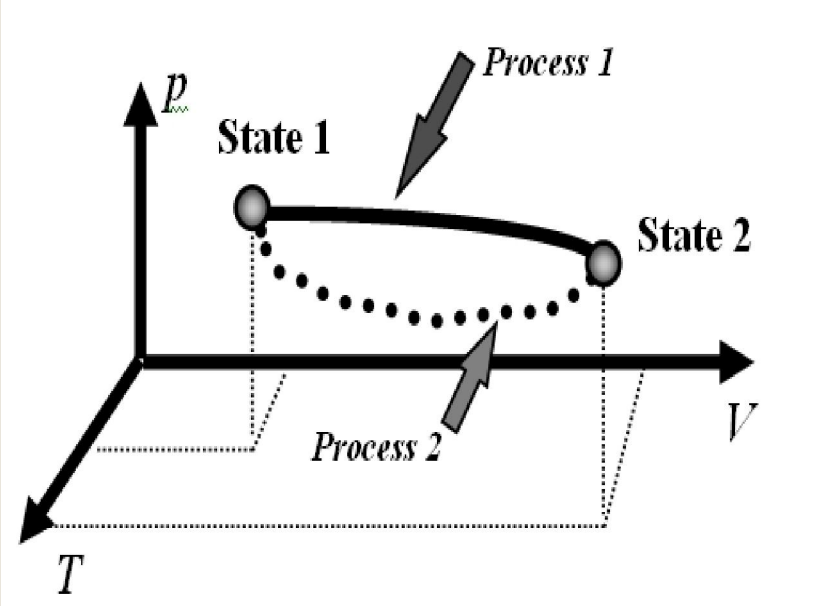
  a series of change of state such that final state is same as initial state it is called cycle

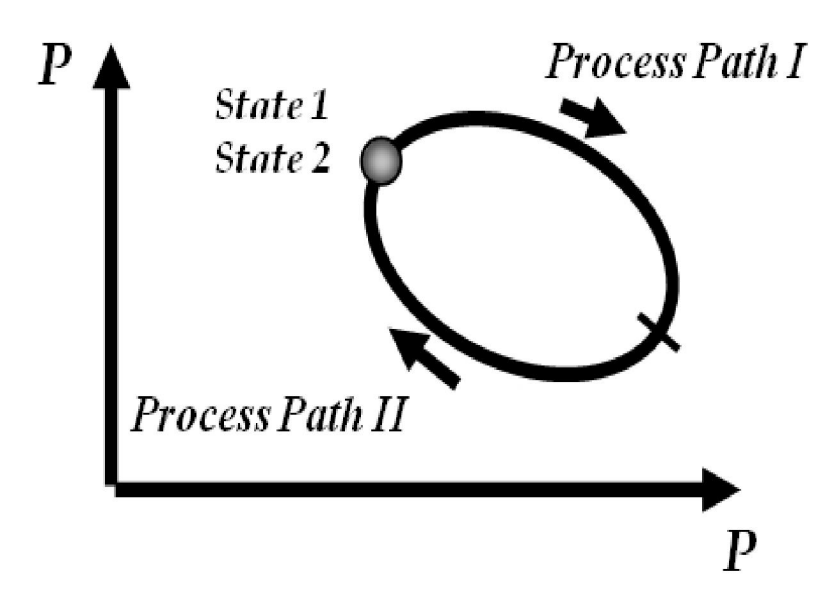
Thermodynamic State, Path and Process





Thermodynamic Path and Cycle





Types of Process

Process	Property remains constant
1. Isothermal	Temperature (T)
2. Isentropic	Entropy (s)
3. Isochoric	Volume (v)
4. Isenthalpic	Enthalpy (h)
5. Isosteric	Concentration
6. Adiabatic	No heat addition or removal
7. Isobaric	Pressure (p)

Thermodynamic Equilibrium

- Equilibrium means a condition of balance.
- A system is said to be in an equilibrium state if its properties will not change without some perceivable effect in the surroundings. Therefore in the equilibrium case the system is isolated from its surroundings.
- In thermal equilibrium state, all the thermodynamic properties remain constant throughout the state. Therefore there is not any spontaneous change occur in the macroscopic property of the thermodynamic system.

Thermodynamic Equilibrium

- To fall the system under the thermodynamic equilibrium state, it should have to satisfy following three types of equilibrium condition.
  - Mechanical equilibrium
  - Chemical equilibrium
  - Thermal equilibrium

- The system is said to be in mechanical equilibrium if there is an absence of any unbalanced pressure or force within the system itself and between system and surrounding.

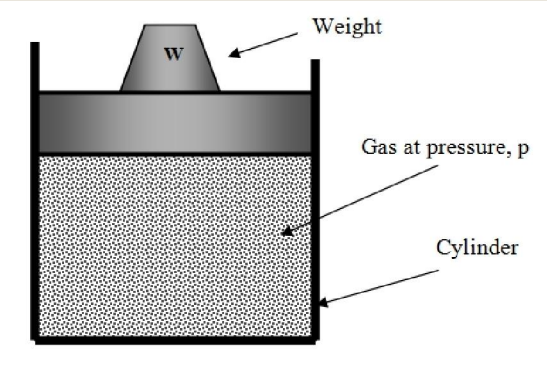
Thermodynamic Equilibrium

- The system is said to be in chemical equilibrium, if there is no chemical reaction or no mass transfer occur between one part of the system to another and also between system and surrounding.
- The system is said to be in thermal equilibrium, if there is no temperature change or no heat transfer occur between one part of the system to another and also between system and surrounding.
- If the system is not satisfying any of the three types of equilibrium, is said to be in a non-equilibrium state. A system in thermodynamic equilibrium does not deliver anything to its surrounding.

Quasi-Static Process

- A process is said to be Quasi-Static process when all states of the system passes through are equilibrium states. That means the deviation from the thermodynamic equilibrium is infinitesimal.

- In the case of a gas contained piston-cylinder, if we remove the weights slowly one by one the pressure of the gas will displace the piston gradually, it is quasi-static process.



Work and heat transfer

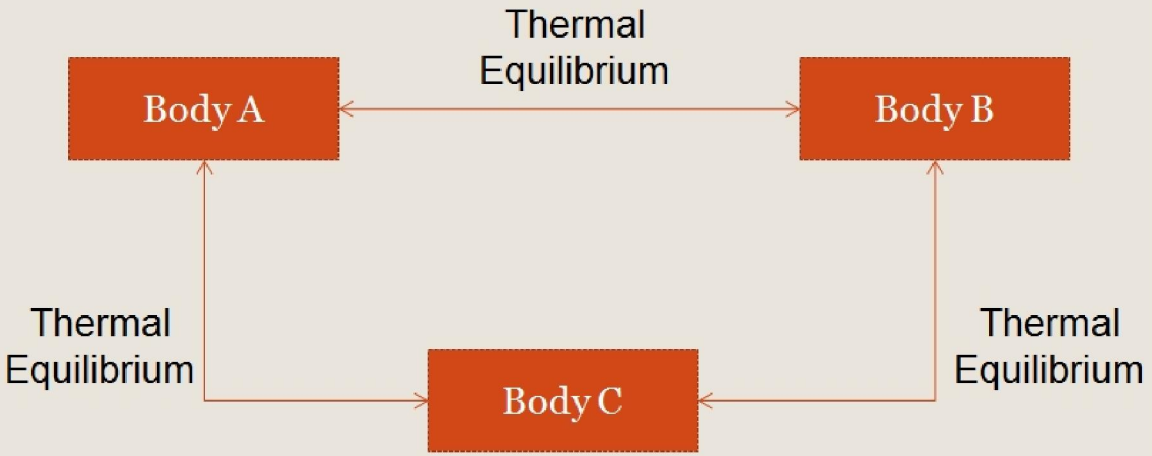
- Displacement Work or pdV work
- Flow work
- Shaft work

Two types of functions

1. Path function
2. Point function

Zeroth law of thermodynamics

When a body A is in thermal equilibrium with a body B, and also with a body C, then B and C will be in thermal equilibrium with each other.



First law of thermodynamics

Energy can neither be created nor be destroyed, it can be converted from one form to another form.

Mathematically,

$$\Delta E = Q - W$$

for cyclic process

$$\Delta E = 0$$

$$Q - W = 0$$

Enthalpy and Entropy

- Enthalpy

  it can be defined as the summation of internal energy and flow energy of a substance.(unit KJ/Kg)

  mathematically,

  $$H=U+PV$$

- Entropy

  Entropy is a function of a quantity of heat which shows the possibility of conversion of that heat into work.(unit KJ/K)

Second law of thermodynamics

- Clausius statement

  it is impossible to have a device that while operating in a cycle produces no effect other than transfer of heat from a body at lower temperature to a body at higher temperature.

- Kelvin-plank statement

  it is impossible for a device operating in a cycle to produce net work while exchanging heat with bodies at single fixed temperature.


Thanks. . . .