

# ***INTRODUCTION***

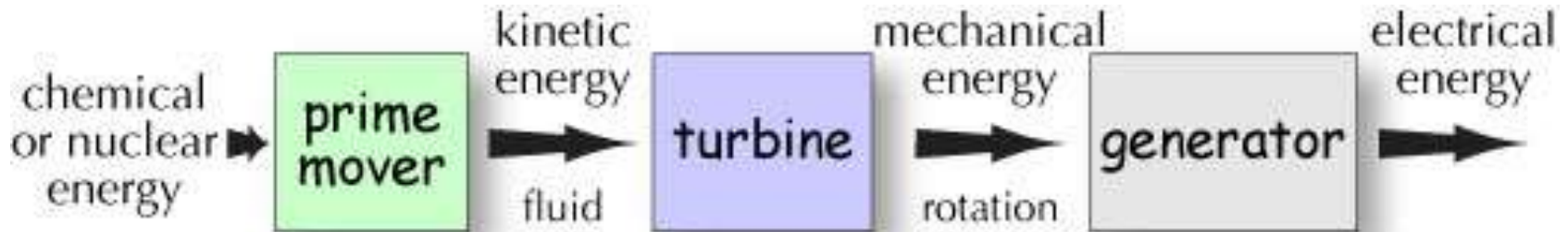
*Course : B.Tech Mechanical*  
*Subject : Elements of Mechanical Engineering*  
*Unit-1*

# ***CONTENTS***

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- Types of prime movers,
- Force and mass, Pressure, Work, Power, Energy, Heat,
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- Interchange of heat, Change of state,
- Mechanical equivalent of heat, Internal energy, Enthalpy, Entropy, efficiency,
- Statements of Zeroth Law,
- First law and Second Law of Thermodynamics

# PRIME MOVER

- In engineering, a prime mover is an engine that converts fuel to useful work.
- So anything that converts fuel energy into useful work is a prime mover.



# SOURCES OF ENERGY

- Various energy sources.
  1. Conventional energy sources
    - Coal, oil, uranium
  2. Non conventional energy sources
    - Energies like Solar, wind, biogas and biomass, ocean thermal, geothermal, fuel cells, hydrogen, tidal etc.

# TYPES OF PRIME MOVERS

- There are a wide variety of different types of prime movers. Each is designed to use a different type of energy source.
  1. Thermal prime movers
    - E.g. Heat engines
  2. Electric power prime movers
    - Electric motors
  3. Hydraulic power prime movers
    - Turbines

# BASIC DEFINATIONS

- Force and Mass:

Something which changes or tends to change the state of rest or of uniform motion of a body in a straight line is called force.

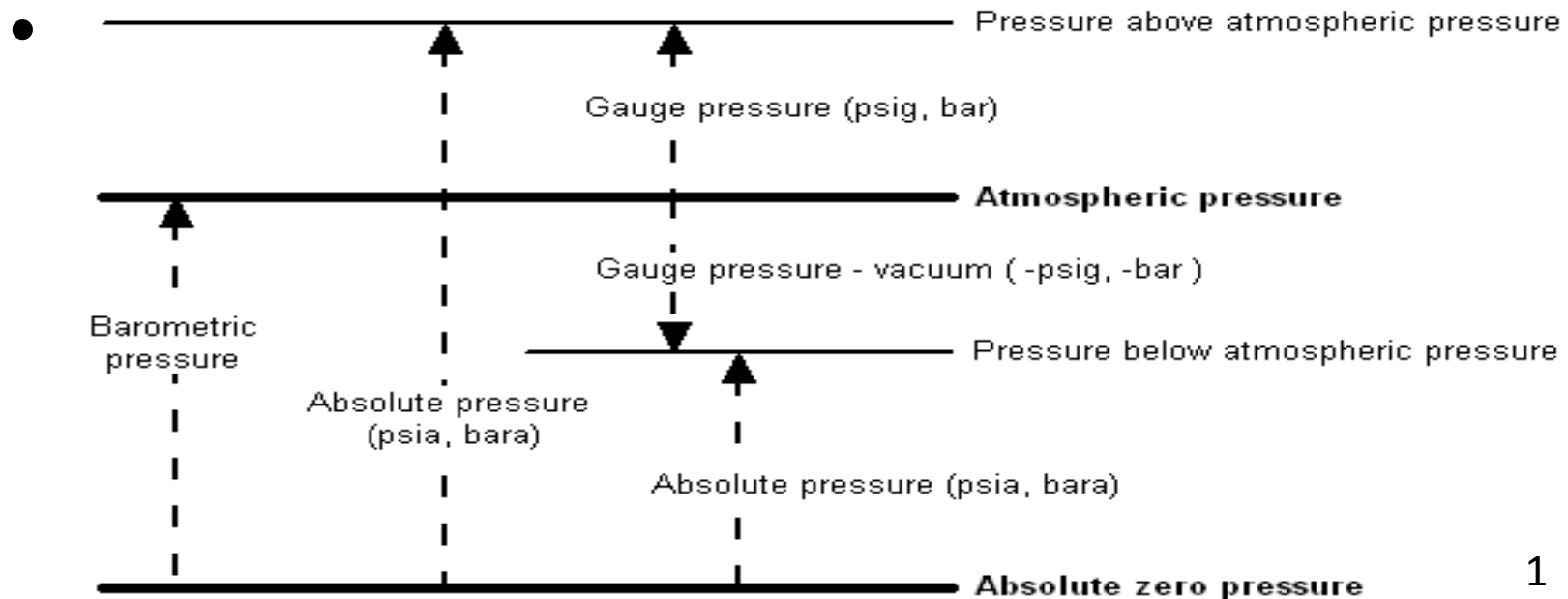
Its defined by Newton's second law of motion.

Unit is Newton (N)

- Mass is the amount of matter contained in a body.

Unit is kg.

- Pressure:
- Pressure is force per unit area.  
 $P = F/A$ .
- Its units are atmosphere, bar, Pascal.  $N/m^2$ .
- A diagram for relation between relative pressure and absolute pressure is shown here.



- Units of pressure & its relation:

$$1 \text{ N/m}^2 = 1 \text{ Pascal}$$

But,  $1 \text{ bar} = 10^5 \text{ Pascal}$

So,  $1 \text{ bar} = 10^5 \text{ N/m}^2$

- It can also be measured by taking reference of the pressure of Mercury (Hg).
- $1 \text{ atm} = 1.01325 \text{ bar} = 760 \text{ mm of Hg}$ .



- Work:

A force is said to do **work** when it acts on a body, and there is a displacement of the point of application in the direction of the force.

i.e, as the bowler throws the ball, he works on ball by applying force.

- It is denoted by  $W = F \cdot D$

here  $F$  = force

$D$  = distance covered by object

- Unit of work is Joule.

- Power:

It is known by work done in unit time.

or

Rate of doing work.

$$P=W/s$$

- The SI unit of power is watt.
- 1 watt=1 J/s
- Other units are KW, MW, etc.

- Energy:  
**energy** is  
a property of objects, transferable among  
them via fundamental interactions, which can  
be converted in form but not created or  
destroyed.
- Unit of energy is joule(J).

- Heat:

Simply we can say about heat,

**heating** is transfer of energy, from a hotter body to a colder one, other than by work or transfer of matter.

It occurs spontaneously whenever a suitable physical pathway exists between the bodies.

- SI unit of heat is also joule(J).

- Temperature:

A **temperature** is a numerical measure of hot and cold.

or we can say

thermal state of body which distinguishes a hot body from a cold body.

- Main units of temperature is centigrade, Fahrenheit, Kelvin, etc.

# SPECIFIC HEAT

- The **specific heat** is the amount of **heat** per unit mass required to raise the temperature by one degree Celsius.
- $Q = m c dT$
- Here the product of mass and heat is known as **HEAT CAPACITY** of substance.

# INTERNAL ENERGY

- It is the energy stored in the system.
- Joule's law of internal energy states that internal energy of perfect gas is only depends on temperature.
- It is denoted by  $U$ .
- We can't measure internal energy but we can find change in it.

# ENTHALPY

- **Enthalpy** is a defined thermodynamic potential, designated by the letter "H", that consists of the internal energy of the system (U) plus the product of pressure (P) and volume (V) of the system:

$$H=U+PV$$



# ENTROPY

- **Entropy** is a law of nature in which everything slowly goes into disorder.
- The entropy of an object is a measure of the amount of information it takes to know the complete state of that object, atom by atom.
- The entropy is also a measure of the number of possible arrangements the atoms in a system can have. In this sense, entropy is a measure of uncertainty.

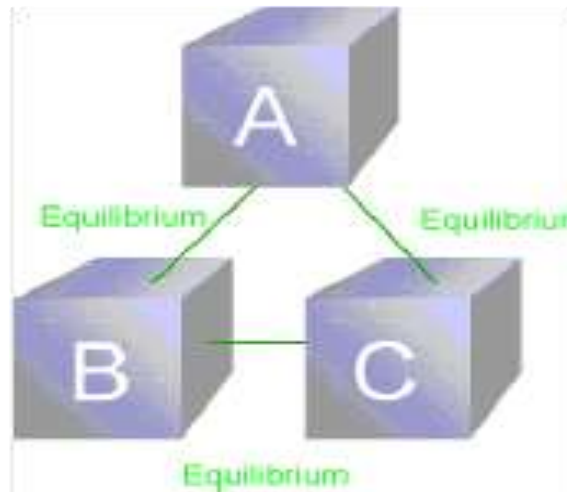
# EFFICIENCY

- It can be defined as the ratio of work output to the given work.
- The work we achieve from the system by giving unit work is the Efficiency of system.

$$\eta = \frac{\text{Work Output}}{\text{Work input}} \times 100\%$$

# ZEROth LAW OF THERMODYNAMICS

- The **zeroth law of thermodynamics** states that if two thermodynamic systems are each in thermal equilibrium with a third, then all three are in thermal equilibrium with each other.



# FIRST LAW OF THERMODYNAMICS

- Energy is neither created nor destroyed, thus the energy of the universe is a constant. However, energy can certainly be transferred from one part of the universe to another.

# SECOND LAW OF THERMODYNAMICS

- **CLAUSIUS STATEMENT:** It is impossible for a self acting machine working in a cyclic process unaided by any external agency, to convey heat from a body at a lower temperature to a body at a higher temperature.

- **KELVIN PLANK STATEMENT:** It is impossible to construct an engine, which while operating in a cycle produces no other effect except to extract heat from a single reservoir and do equivalent amount of work.