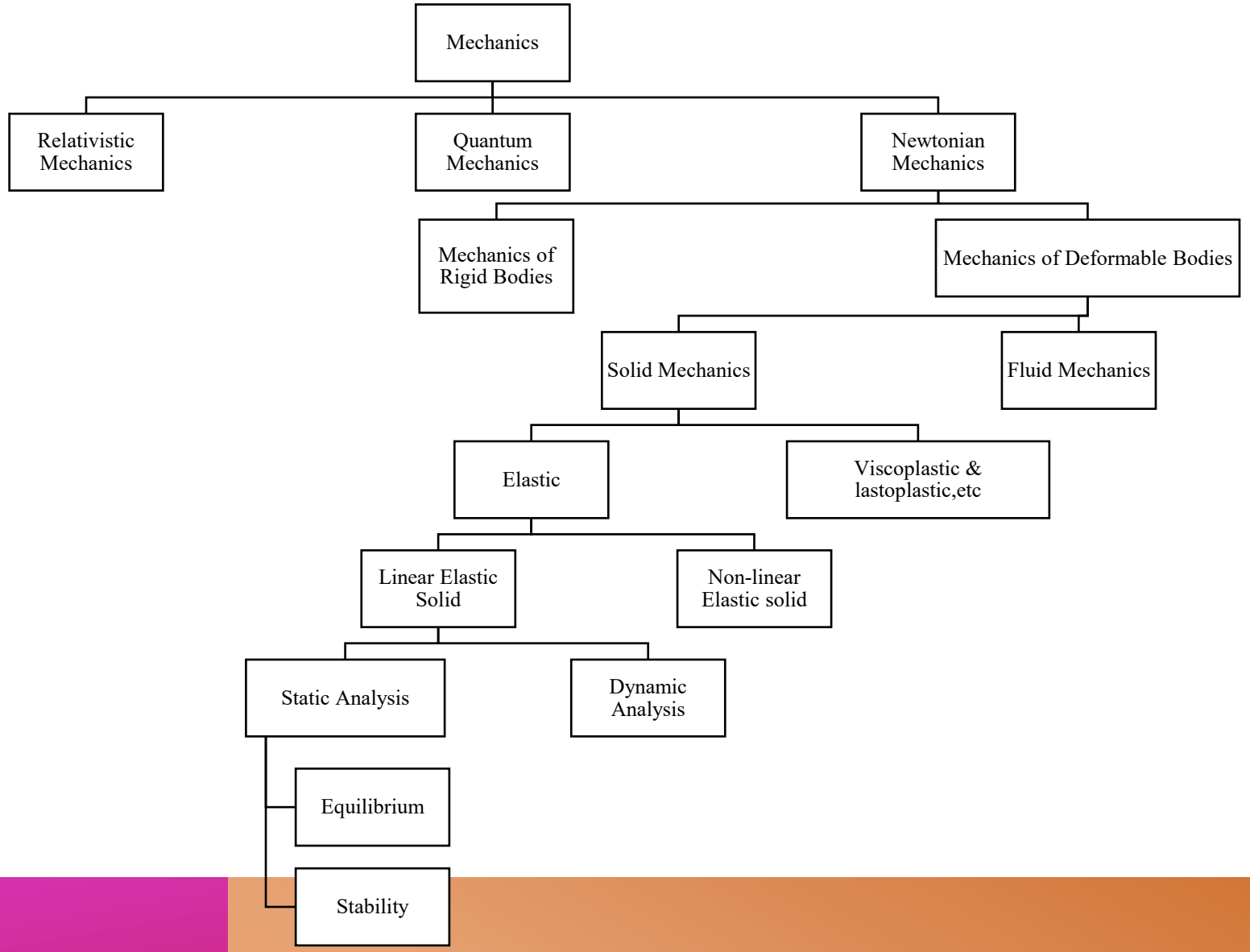
APPLIED MECHANICS
CHAPTER-1 : INTRODUCTION

MECHANICS

- Mechanics is a branch of science which deals with force that influences the particles or rigid bodies and their behavior under the action of such force.
- ***"Engineering mechanics is a branch of engineering which deals with the application of mechanics to solve the engineering related problems."***

CLASSIFICATION OF MECHANICS



CLASSIFICATION OF MECHANICS

- *Newtonian Mechanics or Engineering Mechanics deals with the effect of force on the large masses and low velocity.*

- *Relativistic Mechanics deals with the bodies having large speed near to the speed of light.*

- *Quantum Mechanics deals with the largely small particles having negligible mass and size (e.g. Atomic and sub-atomic particles)*

NEWTONIAN OR ENGINEERING MECHANICS

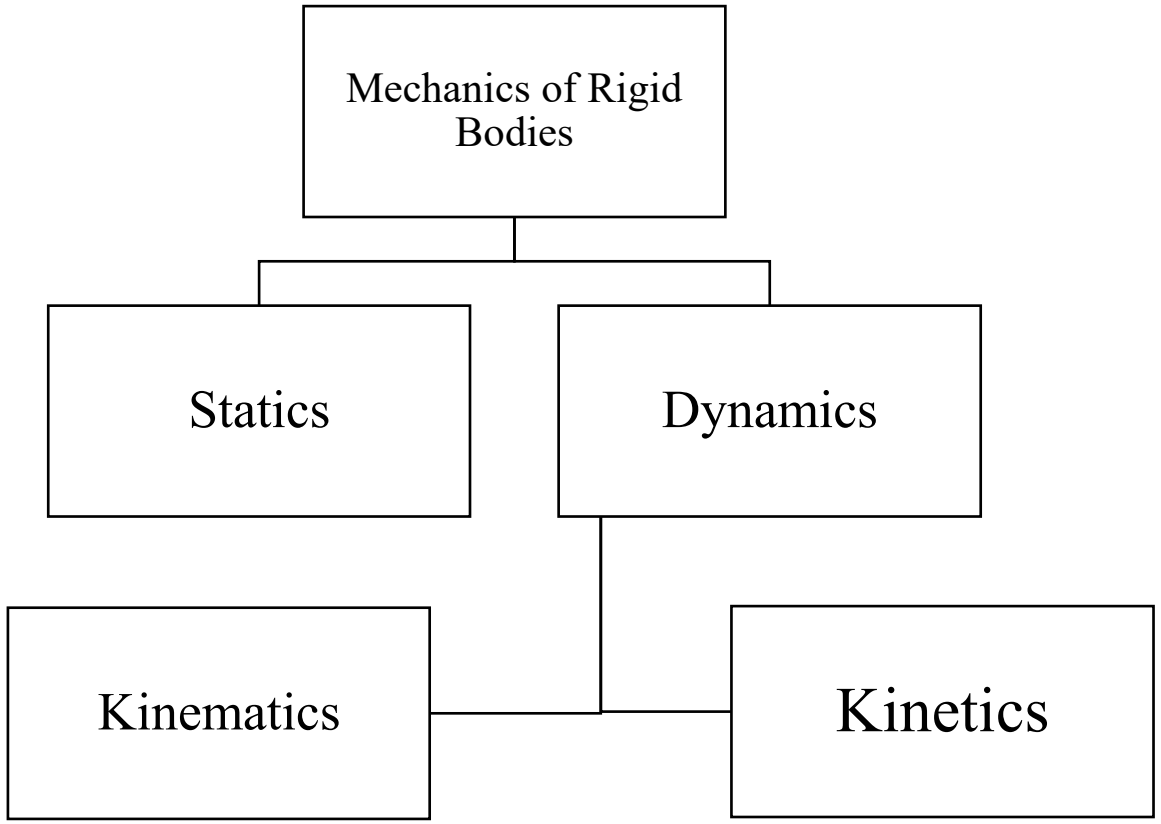
a. Mechanics of Rigid Bodies

Mechanics of Rigid Bodies deals with the static and dynamic behavior of rigid bodies under various types of forces/ loadings.

b. Mechanics of Deformable Bodies

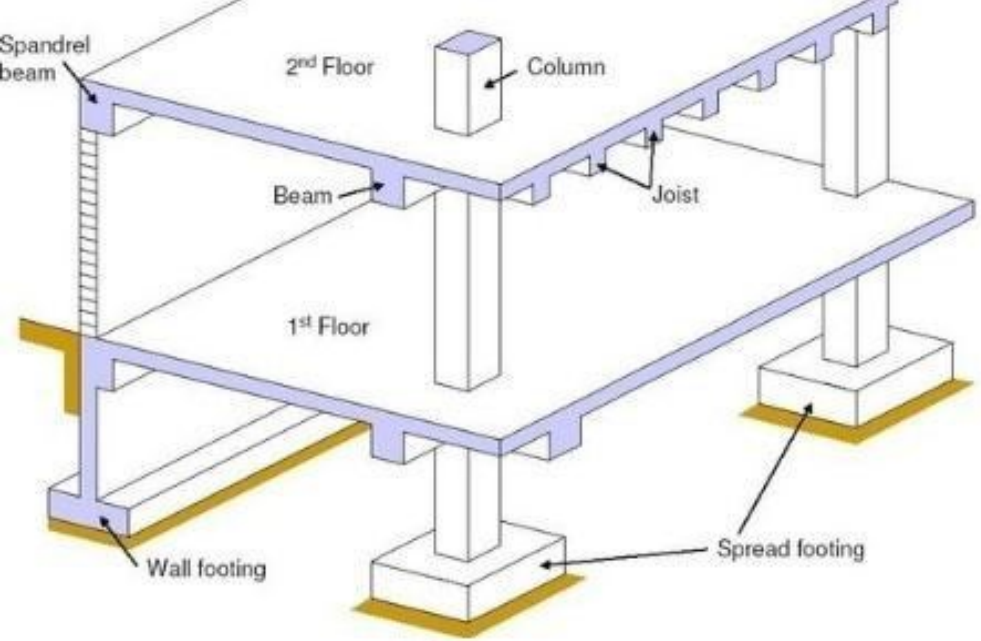
Mechanics of Deformable bodies deals with the deformable bodies which will be studied under fluid mechanics and strength of materials as well as other related subjects.

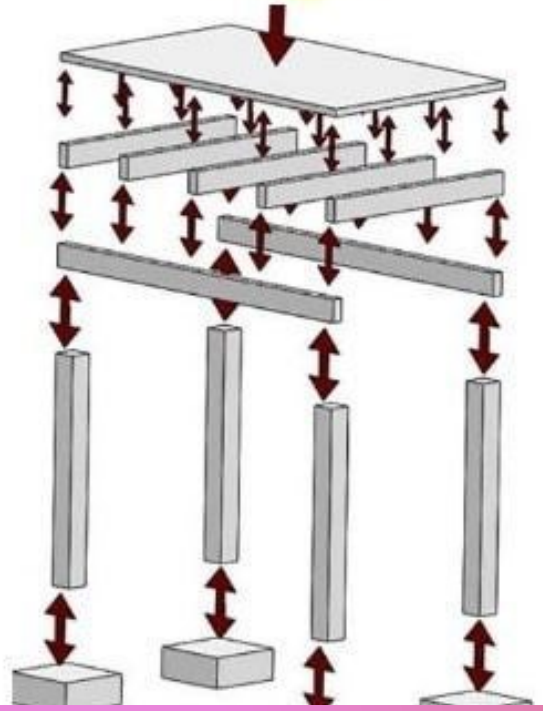
MECHANICS OF RIGID BODIES

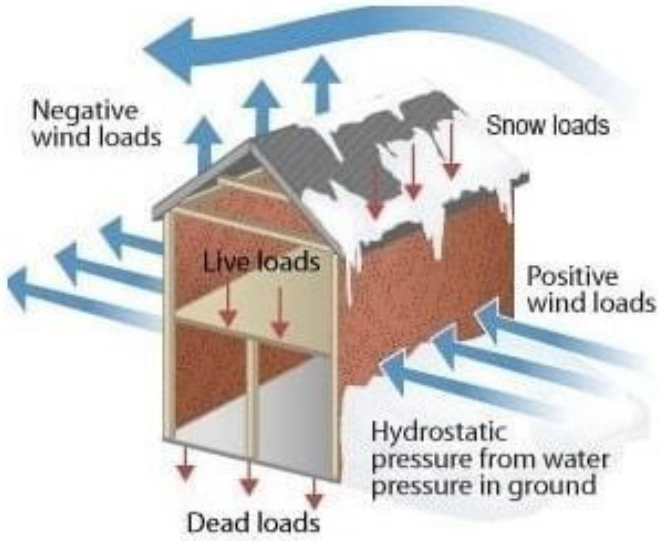


MECHANICS OF RIGID BODIES

1. **Statics**: It deals with the rigid bodies at rest.
2. **Dynamics**: It deals with the rigid bodies in motion. It is again divided into 2 types:
   a. **Kinematics:** It deals with the rigid bodies in motion without considering the cause i.e. force responsible for the motion. Displacement, velocity, acceleration, time are considered.
   b. **Kinetics:** It deals with the rigid bodies in motion considering the cause responsible for the motion. It means force and motion of the body is considered.







SCOPE OF APPLIED MECHANICS

Civil Engineering:

design and analysis of structural members like beam, columns, foundation, etc require the concept of applied mechanics in civil engineering

SCOPE OF APPLIED MECHANICS

- Mechanical Engineering:

The design of mechanical parts of various machines requires the concept of friction, load pattern, stability which is linked with applied mechanics.

SCOPE OF APPLIED MECHANICS

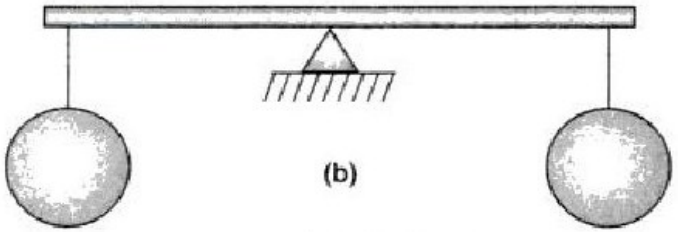
Computer Engineering:

Computer programming can be used to solve a lengthy problems in a easier and efficient way which saves a lot of time.

CONCEPT OF RIGID AND DEFORMED BODIES

Particle:

• A particle can be defined as that object which has mass bu infinitely small volume that can be neglected.



Rigid Bodies:

• A body is simply the combination of those particles. If the distance between the two particles remain constant on application of the force, it is rigid body. So ***Rigid bodies are the combination of large number of particles whose shape and size remains same on application of forces on them i.e. don't get deformed.***

• Rigid bodies can have any shape cuboid, disc, rod, etc

FUNDAMENTAL CONCEPT AND PRINCIPLE OF MECHANICS: NEWTONIAN MECHANICS

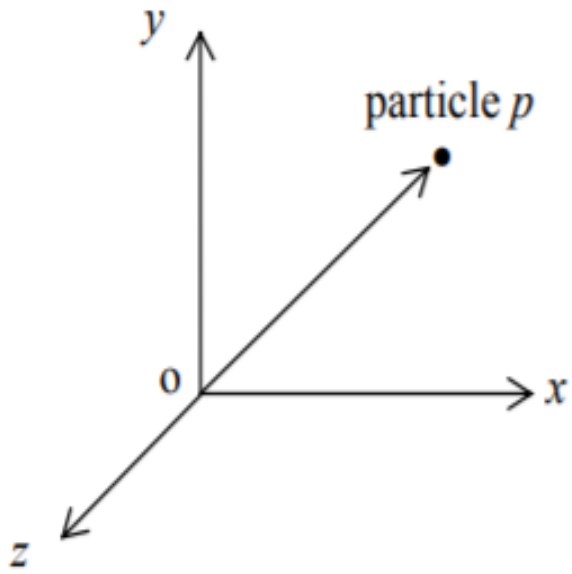
- The fundamental concept of mechanics in engineering is based on Newton's law which is called Newtonian Mechanics which was given by Sir Isaac Newton. However, Einstein's Theory of Relativity challenges the Newtonian concept which is in use nowadays.
- There are four fundamental concepts which is used in mechanics which are:

a. Space
b. Time
c. Mass
d. Force

FUNDAMENTAL CONCEPTS

Space:

- The concept of space is associated with positioning of a point which is generally done using co-ordinate system (in which three distances are measured from a common origin)



FUNDAMENTAL CONCEPTS

Time:

- The concept of time is to measure the duration of the events when the material is in motion so it is not used in analysis of materials at rest or statics.

Mass:

- Mass is the total quantity of matter present in a body. It is the measure of translational inertia i.e. inability of a body to changes its state of rest or motion. The concept of mass is used to compare two bodies on the basis of fundamental mechanical experiments. The concept of mass is used in Newton's laws to define the relationship between acceleration and force.

Force:

- Force is something that cause matter to change the state of motion or rest. It represents the action of one body on another. Force is a vector quantity. The action of a force is characterized by its magnitude, by the direction of its action and by its point of application.

PRINCIPLE OF MECHANICS: NEWTONIAN MECHANICS

The study of mechanics is based on 4 fundamental principles:

1. Newton's Laws of Motion
    a. Newton's 1st law of motion
    b. Newton's 2nd law of motion
    c. Newton's 3rd law of motion
2. Newton's Law of Gravitation
3. Parallelogram Law of Forces
4. Principle of transmissibility of force

NEWTON'S LAWS OF MOTION

a. Newton's 1st law of motion

Every body continues to be in the state of rest or motion until external agency called force acts on it. i.e. If the resultant force acting on a particle is zero, then the particle is in equilibrium. It gives qualitative definition of force.

b. Newton's 2nd law of motion

The rate of change of momentum is directly proportional to the applied force and takes place in the direction of the force. It gives the quantitative definition of force.

i.e. F = ma

Where, F = Resultant Force

m = mass

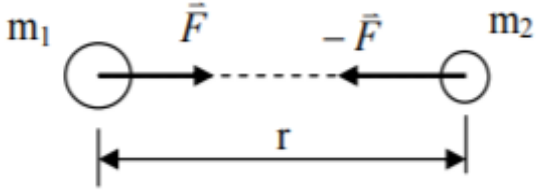
a = acceleration

c. Newton's 3rd law of motion

"To every action there is equal and opposite reaction."

NEWTON'S LAW OF GRAVITATION

- "Every body in this universe attracts another body with a force which is directly proportional to the product of their masses and inversely proportional to the distance between them."



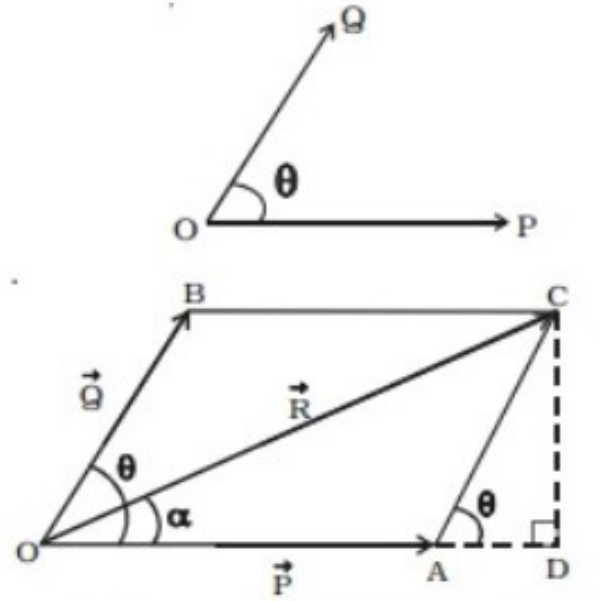
$$\mathbf{F} = \frac{\boldsymbol{Gm_1m_2}}{\boldsymbol{r^2}}$$

- When a particle is at the surface of earth, the force exerted by the earth on the particle is then defined as the weight W of the particle.

$$\mathbf{i.e.\ W = mg}$$

PARALLELOGRAM LAW OF FORCES

- The **law of parallelogram of forces** states that "if two vectors acting on a particle at the same time be represented in magnitude and direction by the two adjacent sides of a parallelogram drawn from a point their resultant vector is represented in magnitude and direction by the diagonal of the parallelogram drawn from the same point."



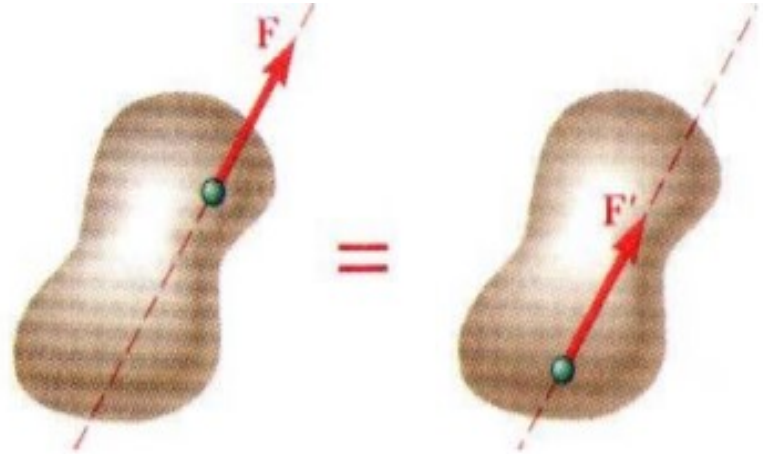
$$\mathbf{R} = \sqrt{P^2 + Q^2 + 2PQcos\theta}$$

And direction of resultant is

$$\alpha = tan^{-1}\left[\frac{Qsin\theta}{P+Qcos\theta}\right]$$ with $\vec{P}$.

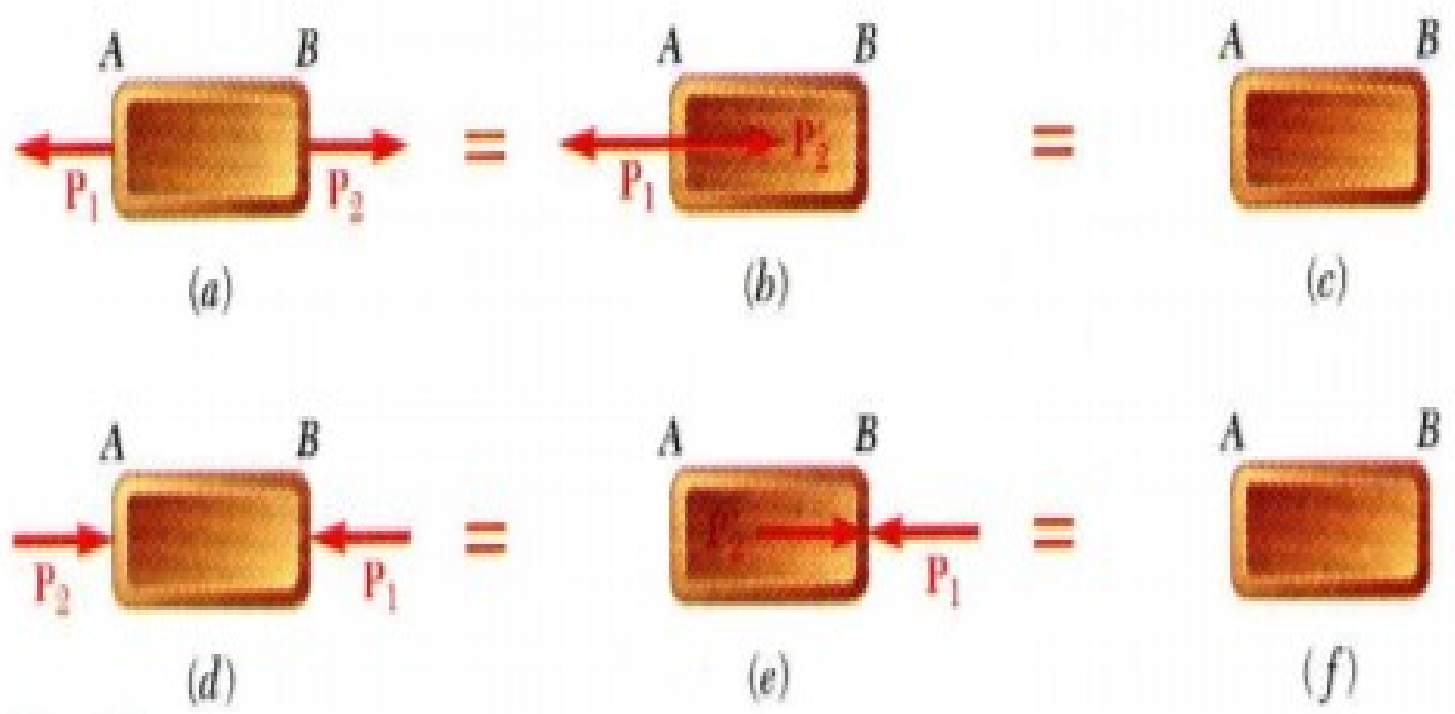
PRINCIPLE OF TRANSMISSIBILITY OF FORCE

- The effect of a force on a rigid body will remain unchanged if the forced is moved to act on its line of action. In other words, a force may be applied at any point on its given line of action without altering the resultant effects on the rigid body on which it acts.



LIMITATIONS OF PRINCIPLE OF TRANSMISSIBILITY

- Principle of transmissibility may not always apply in determining internal forces and deformations.



ANY QUESTIONS ??

THANK YOU