ME-203

INTRODUCTION TO ENGINEERING MECHANICS

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Introduction

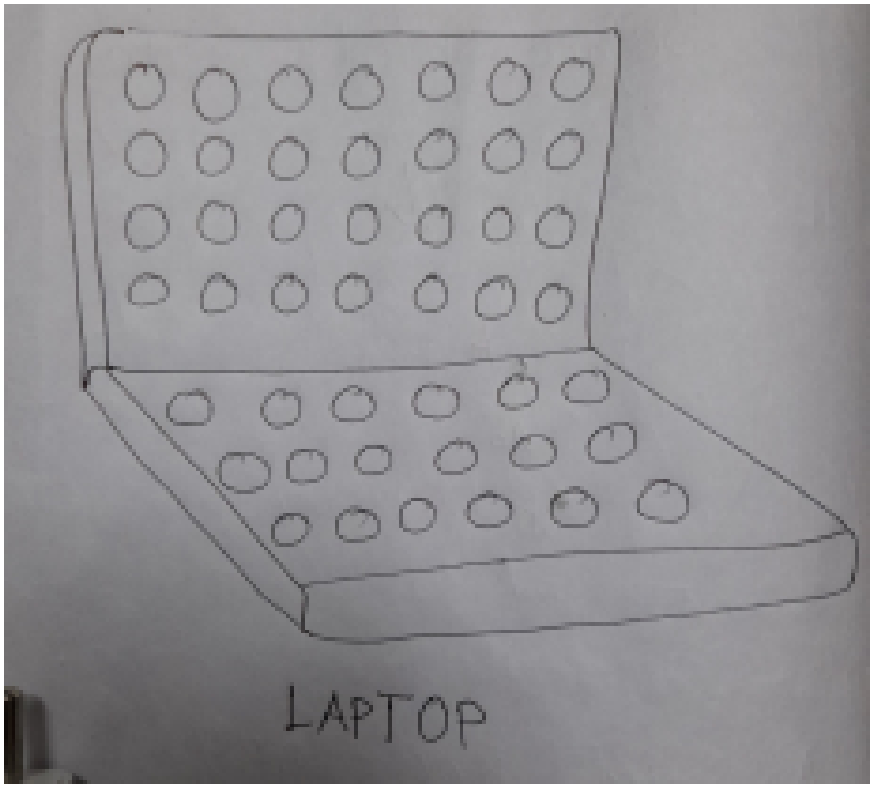
Concept of continuum in Engineering Mechanics/Idealization of Mechanics

➢Continuum mechanics is a branch of mechanics that deals with the mechanical behavior of materials modeled as a continuous mass rather than as discrete particles. The French mathematician Augustin-Louis Cauchy was the first to formulate such models in the 19th century.

➢A continuum is an idealization of continuous description of matter and properties of matter considered as continuous function of space variables. In the molecular concept, there exists an inter molecular space . But in continuum approach actual conglomeration of separate molecules occurs, leaving no empty space within the matter of a system . A continuum may be a rigid body one(solid) or a continuous deformable medium(fluid).

➢Continuum may be defined as a continuous distribution of matter without any voids or empty spaces. Each body is made up of atoms and molecules. The matter is assumed as continuously distributed since the behavior of atoms and molecules are too complex to deal with. It is used to study the measurable behavior.

Examples



Important concepts/Nomenclature and Definitions

In order to have basic understanding of the topic Engineering Mechanics it is recommended to have clear understanding of some nomenclature and useful to understand basic definitions and concepts like

1. Body
2. Particle
3. Rigid body
4. Deformable body
5. Space
6. Primary inertial system or astronomical frame of reference
7. Time
8. Mass
9. Force

Body:
A body is distinct amount of mass ,continuously distributed over a definite volume enclosed by a proper surface . Depending upon the different types and nature of analysis, a body may be needed to be idealized in various ways. Different types of idealization of a body have separate nomenclature, and definite and separate implication.

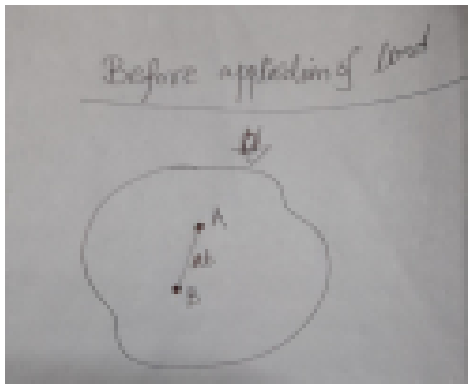
Particle:
A particle is defined as a body the size of which, within a given physical situation is insignificant in the analysis of it's response to the forces that act on it. In other words, if a body is idealized a point of concentrated mass and has significant rotational motion, it is defined as particle.

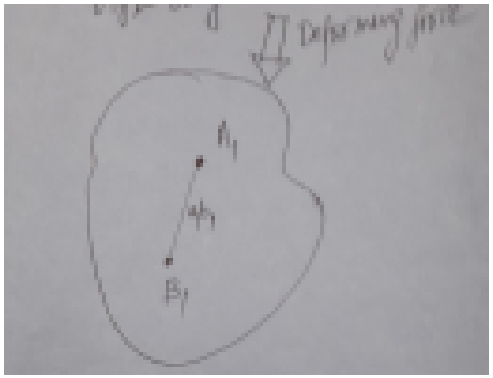
When two or more bodies are idealized as particles and are dealt with together, is called as system of particles. Thus, a system of particles is basically a configuration of particles where the property of each particle is conserved.

Rigid Body and Deformable Body

Rigid body:

A material body is defined as a rigid body, when being subjected to a system of external stimuli, does not change it's geometry and size. In other words, the distance between two arbitrarily chosen points in a rigid body is invariant, whether it is subjected to external stimuli or not. Basically, in a rigid body the generalized deformation(elongation, contraction, and twist) is ignored during analysis, because either the deformation is too small or has very little effect on it's motion or equilibrium.





Deformable body:

A material body is defined as a deformable body, when being subjected to a system of external stimuli, essentially change it's geometry and size. This deformation may be instantaneous or continuous, temporary or permanent.

Space & Primary Inertial System

Space:

Space is a geometric region occupied by a body whose position is described by the linear and angular measurements, with respect to the origin of a chosen coordinate systems.

Primary Inertial System or Astronomical frame of Reference:

The basic frame of reference for the laws of Newtonian mechanics is primary inertial system or astronomical frame of reference , which is an imaginary set of rectangular axes assumed to have no translation or rotation in space. Measurement show that the laws of Newtonian mechanics are valid for this reference system as long as any velocities involved are negligible compared with the speed of light , which is 300000km/s or 1,86000 mile/s. Measurements made with respect to this reference are said to be absolute and this reference system may be considered fixed in space.

Time:
Time is a measure of the succession of events and is considered an absolute quantity in Newtonian mechanics.

Mass:
Mass is the quantity measure of the inertia or resistance to change in motion of a body. Mass may also be considered as the quantity of matter in a body as well as the property which gives rise to gravitational attraction.

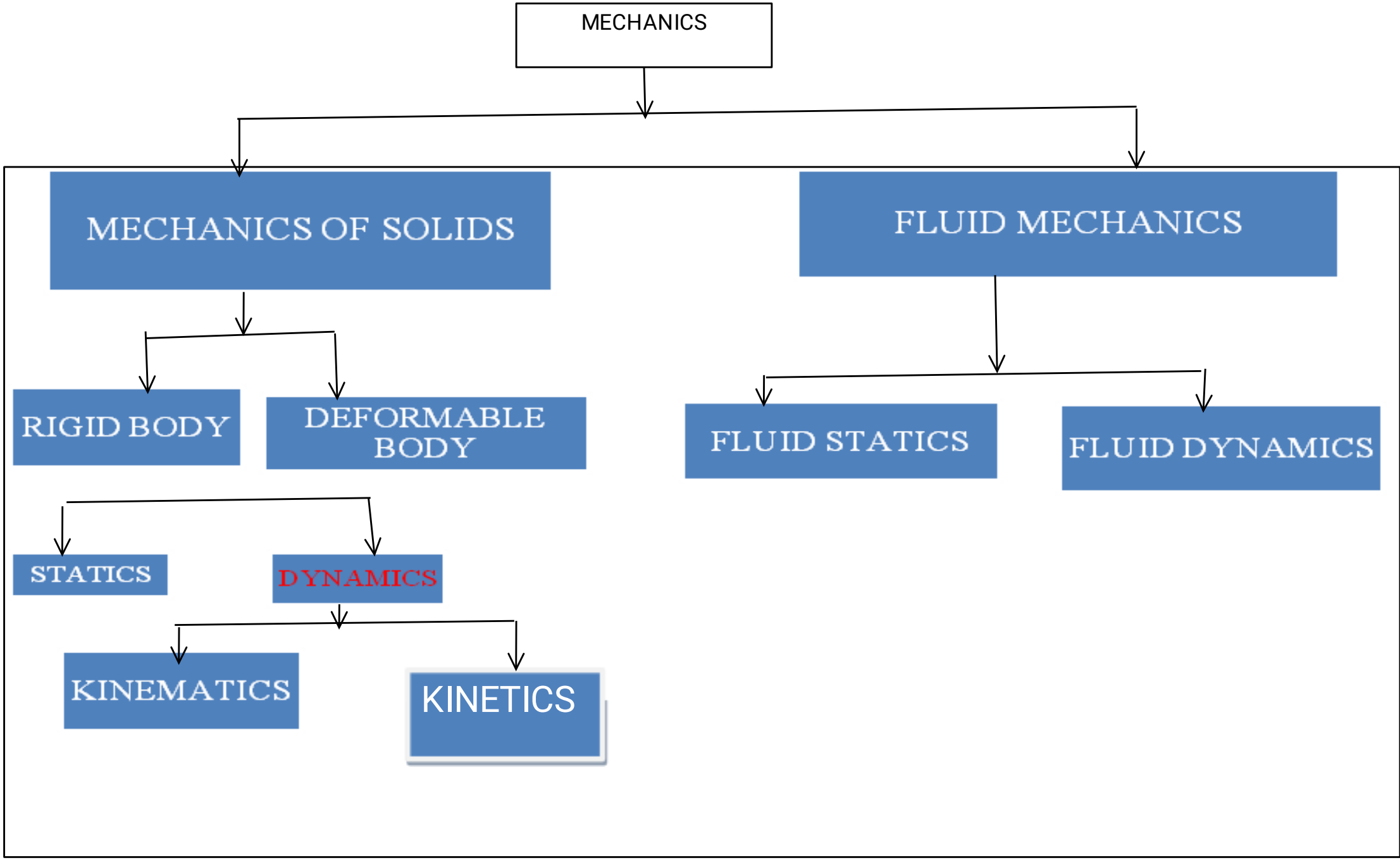
Force:
Force may be defined as any action that tends to change the state of rest or motion of a body to which it is applied. A force or motion acting on a rigid body produces one or both of the following effects.
Linear displacement
Angular(rotational) displacement
This effects essentially result in change in the state of rest or motion of a body.

Force can be specified with it's magnitude, direction and point of

Explanations/Examples

Before defining engineering mechanics, we must consider the similarities and differences between Science and Engineering. In general terms, Science is the knowledge that comes from observing facts about the universe carefully, carrying out experiments and making statements that are always true in a particular conditions. On the other hand engineering is the application of mathematics and science to the design and manufacture of items that serves the purpose. Mechanics may be defined as the Science, which describes and predicts the condition of rest or motion of bodies under the action of forces.
The branch of physical Science that deals with the state of rest or the state of motion is termed as Mechanics. Engineering Mechanics is the branch of engineering that applies the principles of mechanics to design, which must take into account the effect of forces.
Though Mechanics is further studied as follows....

- Classical Mechanics or Newtonian Mechanics or Analytical Mechanics.
- Quantum Mechanics(Behavior of particles when atomic distances are concerned)
- Relativistic Mechanics(Study of mechanics of high speed[speed of light] by Albert Einstein-1878 to 1955.
- However our scope of study is limited to Newtonian Mechanics only.


MECHANICS
MECHANICS OF SOLIDS
FLUID MECHANICS
RIGID BODY
DEFORMABLE BODY
FLUID STATICS
FLUID DYNAMICS
STATICS
DYNAMICS
KINEMATICS
KINETICS

SOLID	FLUID
A substance characterized by some preferred configuration of it's own possessing a definite shape and volume is called a solid.	Fluid is a substance that deforms continuously when subjected to a tangential or shear stress, however small the shear stress may be.
Molecules of the solids are more closely packed as compared to that of fluid. This may be attributed to the fact that attractive forces between the molecules of a solid are much larger than those of a fluid.	Molecules of the fluid are more loosely packed as compared to that of solid.

Formal Definition of Engineering Mechanics

It is one of the oldest branches of Physical Science and perhaps the most powerful that deals with the action of forces on the bodies that are either rest or in motion. Mechanics describes the behavior of bodies, in terms of state of rest or motion, when subjected to forces.

There are few subject of studies associated with the term Mechanics are as follows.

1. Engineering Mechanics Statics
2. Engineering Mechanics Dynamics
3. Mechanics of Materials
4. Fluid Mechanics
5. Fracture Mechanics

To have a clear idea about each of the field of studies are described as follows in a tabu

Engineering Mechanics Statics	Engineering Mechanics Dynamics	Mechanics of Materials	Fluid Mechanics	Fracture Mechanics
It is the branch which deals with the forces and their effects on an object or a body at rest.	Dynamics is the branch of mechanics that deals with the study of objects in motion and the forces causing such motion.	**Mechanics of ma terials** or **Mechan ics** of Deformable Bodies is a field of **Mechanic** whic h studies how structures behave during loading, according to this **definition**, **Mechanics of ma terials** describes the relationship between Loads, Geometries, and **Materials**.	The substance that has tendency to flow is called as fluid. Generally, fluid is defined as a substance which is capable of spreading and changing its shape, according to is surroundings, without offering internal resistance. In fluid mechanics, fluid is defined on the basis of its behavior under the application of external forces	Fracture mechanics is a useful method of characterizing fra cture toughness, fatigue crack growth, or stress-corrosion crack growth behavior in terms of structural design parameters familiar to the engineer, namely stress and flaw size.

For convenience dynamics is conventionally classified into two segments as follows.

Kinematics:

The part of dynamics dealing with the analysis of motion, for example displacement, velocity, acceleration etc of particles and rigid bodies is termed as Kinematics. But it does not take into account of any reference to generalized force system causing or resulting motion. That is the reason why kinematics is some times referred as geometry of motion.

Movement study of cams, gears, projectiles etc are very common examples related to kinematics.

Kinetics:

On the other hand Study of generalized force equilibrium of particles and rigid bodies in motion subjected to external system of force lies within purview of kinetics. So, Kinetics can be defined as the analysis in dynamics associated with laws of motion, inertial effect, work, power, energy, impulse and momentum, simple and complex vibration etc.

Thank You…

Q&A

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