# INTRODUCTION TO MECHANICS

Mechanics is a branch of physics. In general, it allows one to describe and predict the conditions of rest or movement of particles and bodies subjected to the action of forces.

Aristotle was among the first scholars to introduce the term mechanics. At first, the development of mechanics was related to that of knowledge about the modelling of the universe. *Plato, Eudoxus, and Aristotle* are among the creators of the *homocentric system*, whereas *Apollonius, Hipparchus,* and *Ptolemy* created the *epicyclic system*. The theory they developed according to which the motionless Earth is the centre of the Universe is called the *geocentric theory*.

The *heliocentric model,* in which the Sun is the centre of the world, was introduced by *Nicolaus Copernicus* in his fundamental work *De revolutionibus orbium coelesticum (On the Revolution of Heavenly Spheres)*. This view was subsequently modified by Giordano Bruno, who maintained that the solar system was but one of the infinite number of such systems in the universe.

Problems connected with the motion of bodies were raised for the first time by Galileo Galilei, a dedicated proponent of Copernicus's Theory. To Galileo is also attributed the discovery of the Law of the Pendulum (1583) and the Law of Free Falling Objects (1602).

A great contribution to the development of mechanics was made by Johannes Kepler, who

formulated three laws of planetary motion on the basis of empirical observations previously made by Tycho Brahe:

1. All the planets move in elliptical orbits with the Sun at one focus.
2. The position vector of any planet attached at this focus of an orbit where the Sun is located sweeps equal areas in equal time.
3. The squares of the orbital periods of the planets are proportional to the cubes of the semi-major axes of their orbits.

Kepler's three laws served as the foundation of the mechanics of Isaac Newton, who assume that space was homogenous and isotropic and that phenomena are uniform with respect to the choice of the time instant. The equations derived by Newton are invariant with

respect to Galilean transformation. Classical mechanics is also called Newtonian Mechanics.

From Newton's point of view time, space and mass are absolute attributes that are independent of each other. These concepts cannot be a priori defined and are rather motivated by our intention and experience. The concept of mass allows us to compare the behaviour of bodies. For instance, we say that two bodies have the same mas if they are attracted by the Earth in the same manner and they exhibit the same resistance to changes in translational motion.

Newton also introduced the concept of force. It may depend on the mass of the body on which it acts and on the changes in the velocity of the body over time. Therefore force cannot be treated as an absolute, independent attribute of mechanics.

Mechanics can also be defined as the science of the motion of bodies. Instead of using real objects, mechanics make use of their models. In general, the model of a given object is an image reflecting only those attributes of the object that are essential to investigate the phenomena of interest for a particular branch of science.

The law of mechanics introduced by Newton serve to illuminate the motions of material systems. They enable us to create a mathematical model, that is, to formulate equations of motion of particles and bodies.

The main goal of mechanics is to formulate the laws of motion suitable for the investigation of a variety of real bodies. It turns out that any real body, solid, liquid, or gaseous, can be modelled as a collection of particles. The following are branches of mechanics:

1. Mechanics of rigid bodies (statics and dynamics).
2. Mechanics of deformable bodies (strength of materials, elasticity theory, plastic theory, or rheology).
3. Mechanics of fluids: incompressible (mechanics of liquids) and compressible (mechanics of gases, aeromechanics); the mechanics of incompressible fluids such as water is known as hydraulics.

In technical mechanics, during the modelling process we deal with the geometry (decomposition of mass and the description of materials from which bodies are formed. In rigid mechanics, we assume that the distance between any two points of a body does not change. We can talk about a completely different problem when there is a possibility of changing the distance between the points of a body.

The laws originally formulated by Newton generated a set of other fundamental laws of mechanics, such as the conservation of linear momentum, the conservation of angular momentum, and the conservation of kinetic energy. The interaction of bodies can be implemented by the direct pressure of one body on another or by indirect reaction at a distance.

The latter case is connected with Newton's law of gravitation since, if we consider two particles of masses $m_1$ and $m_2$, the gravity for $F_{12}$ with which the particles of the mass $m_2$ attracts $m_1$ is given as

$$F_{12} = \frac{Gm_1m_2}{r^3}.r_{12}$$

Where $G = 6.67 \times 10^{-11}\ Nm^2kg^{-2}$ and $r_{12}$ is a vector joining these two points and directed from point 1 towards point 2.

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