Introduction

Sunday, June 29, 2025 9:05

# دینامیک

# Dynamics

## Contents — سرفصل مطالب

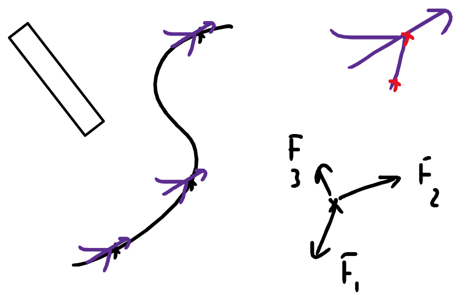


## مراجع


۱- دینامیک، بی یر - جانستون — **Beer-Johnston**

۲- دینامیک، مریام — **Meriam**

۳- دینامیک، هیبلر — **Hibbeler**


* دو شاخه اصلی علم دینامیک:
① سینماتیک kinematics
② سینتیک kinetics

① سینماتیک: مطالعه هندسی حرکت است و از آن ارتباط جابه‌جایی، سرعت، شتاب و زمان پیدا می‌شود، بدون اینکه به دلیل حرکت اشاره شود. $\vec{r}, \vec{v}, \vec{a}, t$

② سینتیک: مطالعه روابط موجود بین نیروهای وارد به جسم و حرکت جسم است. از سینتیک برای پیش‌بینی حرکت ناشی از نیروهای معین و یا تعیین نیروهای لازم برای حرکت معین

برای پیش بینی حرکت ناشی از نیروهای معین و یا تعیین نیروهای لازم برای حرکت معین استفاده می شود.

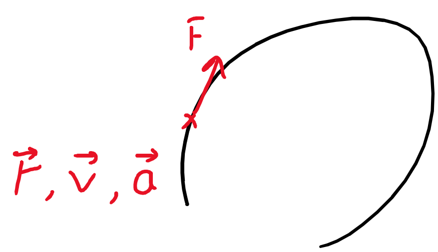
$\vec{F}, \vec{a}, m$ $\qquad$ $\vec{F} = m\vec{a}$

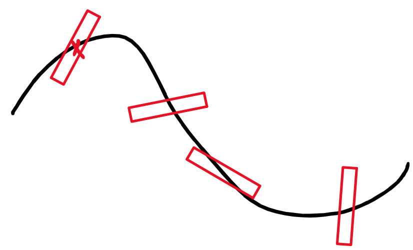
**دینامیک**

① **ذره:** اگر معادله حرکت کل جسم (هر نقطه از جسم) همان معادله حرکت مرکز جرم جسم باشد، جسم ذره محسوب می شود.

② **جسم صلب:** اگر معادله حرکت نقاط مختلف جسم با معادله حرکت مرکز جرم متفاوت باشد یا به عبارت دیگر نقاط مختلف جسم نسبت به هم تغییر مکان نسبی داشته باشد، جسم صلب به حساب می آید.

* با توجه به تعریف ممکن است با توجه به نوع حرکت، یک کشتی یا هواپیما را ذره درنظر بگیریم و یک خودکار را جسم صلب.



$$\vec{F} = m\vec{a} = \frac{d(m\vec{v})}{dt}$$

$$\underbrace{\int F\,dt}_{\text{ضربه}} = \underbrace{m\vec{v}_2 - m\vec{v}_1}_{\text{اندازه حرکت}}$$

$$\int_1^2 F\,dx = \int ma\,dx = \int_{v_1}^{v_2} mv\,dv$$

$$\underbrace{U_{1\to 2}}_{\text{کار}} = \underbrace{\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2}_{\text{انرژی جنبشی}}$$

**فصل بندی**

- دینامیک
  - ذرات
    - سینماتیک ①
    - سینتیک
      - نیرو و شتاب ②
      - انرژی و اندازه حرکت ③
  - اجسام صلب
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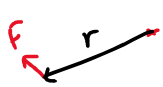
      - نیرو و شتاب ⑤
      - انرژی و اندازه حرکت ⑥

$\vec{M} = \vec{r} \times \vec{F}$




## مفهوم مکانیک برداری

# 1/3 Newton's Laws

توانین نیوتن

Newton's three laws of motion, stated in Art. 1/4 of *Vol. 1 Statics*, are restated here because of their special significance to dynamics. In modern terminology they are:

**Law I.** A particle remains at rest or continues to move with uniform velocity (in a straight line with a constant speed) if there is no unbalanced force acting on it.

$\vec{F} = m\vec{a}$

**Law II.** The acceleration of a particle is proportional to the resultant force acting on it and is in the direction of this force.*

**Law III.** The forces of action and reaction between interacting bodies are equal in magnitude, opposite in direction, and collinear.

*To some it is preferable to interpret Newton's second law as meaning that the resultant force acting on a particle is proportional to the time rate of change of momentum of the particle and that this change is in the direction of the force. Both formulations are equally correct when applied to a particle of constant mass.

$\vec{F} = \frac{d(m\vec{v})}{dt}$

تاریخچه

## History of Dynamics

Dynamics is a relatively recent subject compared with statics. The beginning of a rational understanding of dynamics is credited to Galileo (1564–1642), who made careful observations concerning bodies in free fall, motion on an inclined plane, and motion of the pendulum. He was largely responsible for bringing a scientific approach to the investigation of physical problems. Galileo was continually under severe criticism for refusing to accept the established beliefs of his day, such as the philosophies of Aristotle which held, for example, that heavy bodies fall more rapidly than light bodies. The lack

Galileo Galilei

Isaac Newton

of accurate means for the measurement of time was a severe handicap to Galileo, and further significant development in dynamics awaited the invention of the pendulum clock by Huygens in 1657.

Newton (1642–1727), guided by Galileo's work, was able to make an accurate formulation of the laws of motion and, thus, to place dynamics on a sound basis. Newton's famous work was published in the first edition of his *Principia*,* which is generally recognized as one of the greatest of all recorded contributions to knowledge. In addition to stating the laws governing the motion of a particle, Newton was the first to correctly formulate the law of universal gravitation. Although his mathematical description was accurate, he felt that the concept of remote transmission of gravitational force without a supporting medium was an absurd notion. Following Newton's time, important contributions to mechanics were made by Euler, D'Alembert, Lagrange, Laplace, Poinsot, Coriolis, Einstein, and others.

تعریف فضا و زمان

***Space*** is the geometric region occupied by bodies. Position in space is determined relative to some geometric reference system by means of linear and angular measurements. The basic frame of reference for the laws of Newtonian mechanics is the *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. Measurements 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 300 000 km/s or 186,000 mi/sec. Measurements made with respect to this reference are said to be *absolute*, and this reference system may be considered "fixed" in space.

A reference frame attached to the surface of the earth has a somewhat complicated motion in the primary system, and a correction to the basic equations of mechanics must be applied for measurements made relative to the reference frame of the earth. In the calculation of rocket and space-flight trajectories, for example, the absolute motion of the earth becomes an important parameter. For most engineering problems involving machines and structures which remain on the surface of the earth, the corrections are extremely small and may be neglected. For these problems the laws of mechanics may be applied directly with measurements made relative to the earth, and in a practical sense such measurements will be considered *absolute*.

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

سیستم آحاد

| Quantity | Dimensional Symbol | SI Units | | | U.S. Customary Units | | |
|---|---|---|---|---|---|---|---|
| | | | Unit | Symbol | | Unit | Symbol |
| Mass | M | Base units | kilogram | kg | | slug | — |
| Length | L | Base units | meter* | m | Base units | foot | ft |
| Time | T | Base units | second | s | Base units | second | sec |
| Force | F | | newton | N | Base units | pound | lb |

*Also spelled *metre*.

$F = ma$

$N = kg \cdot \frac{m}{s^2}$

$lb = slug \frac{ft}{s^2}$