Welcome to ENGR 8

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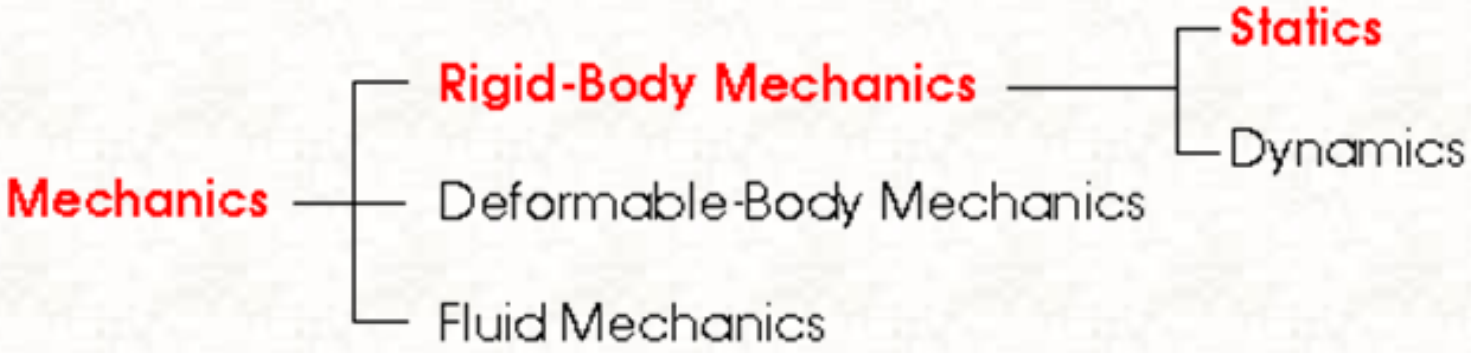
This Week's Agenda

- Syllabus
- Introduction
- Math Review
- Force Vectors

What is "Mechanics"?

Mechanics is the branch of the physical sciences that is concerned with the study of the effects of forces on the state of rest or motion of bodies. The field of mechanics is generally subdivided into the areas of rigid-body mechanics, deformable-body mechanics and fluid mechanics.



Rigid-body mechanics is further subdivided into statics, which deals with the study of rigid bodies at rest or moving at a constant velocity, and dynamics, which deals with the study of accelerated motion of rigid bodies. Statics may be considered as a special case of dynamics where the acceleration is zero, however, it is generally studied separately to ensure a firm grasp of the concepts of force, moment, and physical-mathematical modeling necessary to the study of mechanics.

Basic Quantities

- Length: position, size, distance
- Time: sequence of events (Dynamics)
- Mass: quantity of matter
- Force: contact, qravity

Idealizations

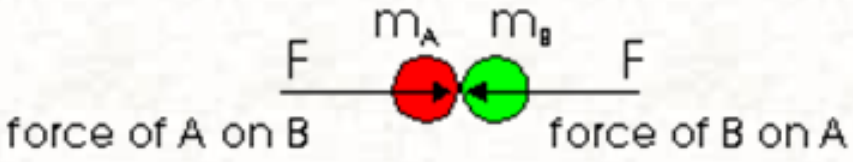
- Particle: mass but no size
- Rigid Body:
  - large number of particles
  - fixed with respect to each other
- Concentrated Force:
  - effect of a loading acting at a point

Newton's laws are the basis of Rigid Body Mechanics

First Law:
A particle originally at rest, or moving in a straight line with constant velocity, will remain in that state provided that the particle is not subjected to an unbalanced force.

Second Law:
A particle acted upon by an unbalanced force **F** experiences an acceleration **a** that has the same direction as the force and a magnitude that is directly proportional to the force.

Third Law:
The mutual forces of action and reaction between two particles are equal in magnitude, opposite in direction, and collinear.



1.3 Newtonian Gravitational Constant

Newton, in addition to the three laws of motion, formulated a law relating the gravitational attraction between two particles. The force of gravitational attraction between two particles is proportional to the product of their masses and inversely proportional to the square of the distance between the masses. Stated mathematically,

$$F = G\, m_1 m_2 /(r^2)$$

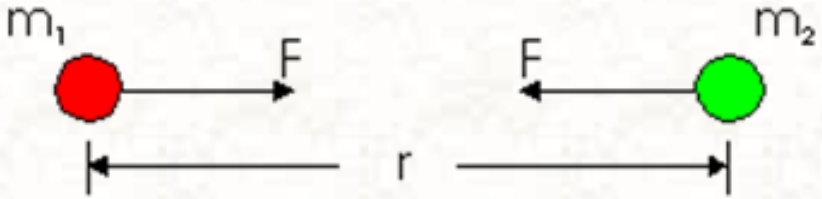
Where

F = force of gravitational attraction

G = universal gravitational constant ($G=66.73 \times 10^{-12}\ m^3/(kg*s^2)$)

m_1, m_2 = mass of each particle

r = distance between the particles



1.3 Newtonian Gravitational Constant

The weight of a particle on the Earth's surface is the force due to the gravitational attraction between the mass of the particle, m, and the mass of the earth, M where R is the radius of the Earth. Thus

$$W = G\,m\,M\,/R^2$$

Letting $g = G\,M\,/R^2$, the weight of a particle on the surface of the earth is

$$W = m\,g$$

The value of g for an object on the Earth's surface varies since the Earth is not a sphere of radius R. However, for most engineering problems, g is considered constant and is taken to be 9.81 m/s^2 or 32.2 ft/s^2.

Units

TABLE 1–1 Systems of Units

Name	Length	Time	Mass	Force
International System of Units	meter	second	kilogram	newton*
SI	m	s	kg	$N \left(\frac{kg \cdot m}{s^2}\right)$
US Customary FPS	foot	second	slug* $\left(\frac{lb \cdot s^2}{ft}\right)$	pound
	ft	s		lb

*Derived unit.

SI units have prefixes

- Giga (G)
- Mega (M)
- Kilo (K)
- milli (m)
- micro (u)
- nano (n)

EXAMPLE 1.1

Convert 2 km/h to m/s How many ft/s is this?

SOLUTION

Since 1 km = 1000 m and 1 h = 3600 s, the factors of conversion are arranged in the following order, so that a cancellation of the units can be applied:

$$2\ \text{km/h} = \frac{2\ \text{km}}{\text{h}}\left(\frac{1000\ \text{m}}{\text{km}}\right)\left(\frac{1\ \text{h}}{3600\ \text{s}}\right)$$

$$= \frac{2000\ \text{m}}{3600\ \text{s}} = 0.556\ \text{m/s} \qquad \textit{Ans.}$$

From Table 1–2, 1 ft = 0.3048 m. Thus,

$$0.556\ \text{m/s} = \left(\frac{0.556\ \text{m}}{\text{s}}\right)\left(\frac{1\ \text{ft}}{0.3048\ \text{m}}\right)$$

$$= 1.82\ \text{ft/s} \qquad \textit{Ans.}$$

NOTE: Remember to round off the final answer to three significant figures.

Rounding

- Answers expressed with 3 significant figures
- Intermediate answers use 4

  4.56 * 1.23 + 1.8 = 5.609 + 1.8 = 7.409 = 7.41
- Round
  - 1.2345 = 1.23
  - 5.678 = 5.69
  - 2.345 = 2.34 (even numbers before 5, don't go up)

End of the Lecture

Let Learning Continue