EM211 - STATICS

Fall AY 07

Sections: 4003, 5002, 6001

Prof. Burkhardt
1. Introduction to Statics

A. Mechanics

→ Deals with the effect of forces on objects
→ Plays a significant role in engineering
→ Vibration, stability, strength, robotics, rockets, engines, fluid flow

→ Primary fields are solid mechanics and fluid mechanics

Mechanics
  → Fluid mechanics
    → Inviscid flow, viscous flow
  → Solid mechanics
    → Dynamics, statics
Mechanics covers much of what you will see as an engineering student.

Oldest branch of the physical sciences

Archimedes (287 - 212 B.C.)
expressed in meters per second per second, or meters per second squared (m/s²). In U.S. Customary units, the velocity is expressed in feet per second (ft/s) and the acceleration is expressed in feet per second squared (ft/s²).

**Newton’s Laws**

Elementary mechanics was established on a firm basis with the publication in 1687 of *Philosophiae naturalis principia mathematica*, by Isaac Newton. Although highly original, it built on fundamental concepts developed by many others during a long and difficult struggle toward understanding (Fig. 12.1).

<table>
<thead>
<tr>
<th>Event</th>
<th>Year</th>
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<tbody>
<tr>
<td>Peloponnesian War</td>
<td>400 B.C.</td>
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<tr>
<td>Roman invasion of Britain</td>
<td>0</td>
</tr>
<tr>
<td>A.D. 400</td>
<td></td>
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<tr>
<td>Coronation of Charlemagne</td>
<td>800</td>
</tr>
<tr>
<td>Norman conquest of Britain</td>
<td>1200</td>
</tr>
<tr>
<td>Signing of Magna Carta</td>
<td>1400</td>
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<tr>
<td>Bubonic plague in Europe</td>
<td>1600</td>
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<tr>
<td>Printing of Gutenberg Bible</td>
<td></td>
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<tr>
<td>Voyage of Columbus</td>
<td></td>
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<tr>
<td>Founding of Jamestown Colony</td>
<td>1600</td>
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<tr>
<td>Thirty Years’ War</td>
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<td>Pilgrims’ arrival in Massachusetts</td>
<td></td>
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<tr>
<td>Founding of Harvard University</td>
<td>1650</td>
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<tr>
<td>Settlement of Carolina</td>
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<tr>
<td>Pennsylvania grant to William Penn</td>
<td></td>
</tr>
<tr>
<td>Salem witchcraft trials</td>
<td>1700</td>
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</tbody>
</table>

**Aristotle:** Statics of levers, speculations on dynamics  
**Archimedes:** Statics of levers, centers of mass, buoyancy  
**Hero of Alexandria:** Statics of levers and pulleys  
**Pappus:** Precise definition of center of mass  
**John Philoponus:** Concept of inertia  

**Jordanus of Nemore:** Stability of equilibrium  
**Albert of Saxony:** Angular velocity  
**Nicole d’Oresme:** Graphical kinematics, coordinates  
**William Heytesbury:** Concept of acceleration  

**Nicolaus Copernicus:** Concept of the solar system  
**Dominic de Soto:** Kinematics of falling objects  
**Tycho Brahe:** Observations of planetary motions  
**Simon Stevin:** Principle of virtual work  
**Johannes Kepler:** Geometry and kinematics of planetary motions  
**Galileo Galilei:** Experiments and analyses in statics and dynamics, motion of a projectile  
**René Descartes:** Cartesian coordinates  
**Evangelista Torricelli:** Experiments on hydrodynamics  
**Blaise Pascal:** Analyses in hydrostatics  

**John Wallis, Christopher Wren, Christiaan Huygens:** Impacts between objects  

**Isaac Newton:** Concept of mass, laws of motion, postulate of universal gravitation, analyses of planetary motions

**Figure 12.1**

Chronology of developments in mechanics up to the publication of Newton’s *Principia* in relation to other events in history.
8. Basic Concepts

Space - 

Time - 

Mass - 

Force - the action of one body on another

- characterized by a magnitude and direction

Particle - a body of negligible dimensions

- a matter of scale: electron / proton

- aircraft at a distance: 747/50 km

Rigid body - a body where the distance between any two points remains largely unchanged (e.g., Bowling Ball)