Introduction (Elastostatics)

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主要参考书

《弹性力学》（上册，第三版）　徐芝纶 编　高等教育出版社

《 Theory of Elasticity 》　Timoshenko

《弹性力学》　吴家龙 编　同济大学出版社

《弹性力学学习方法及解题指导》　王俊民 编　同济大学出版社

The examination of the course included two parts:

(1) Regular grades: 20%

- attendance:10%
- report of TP:10%

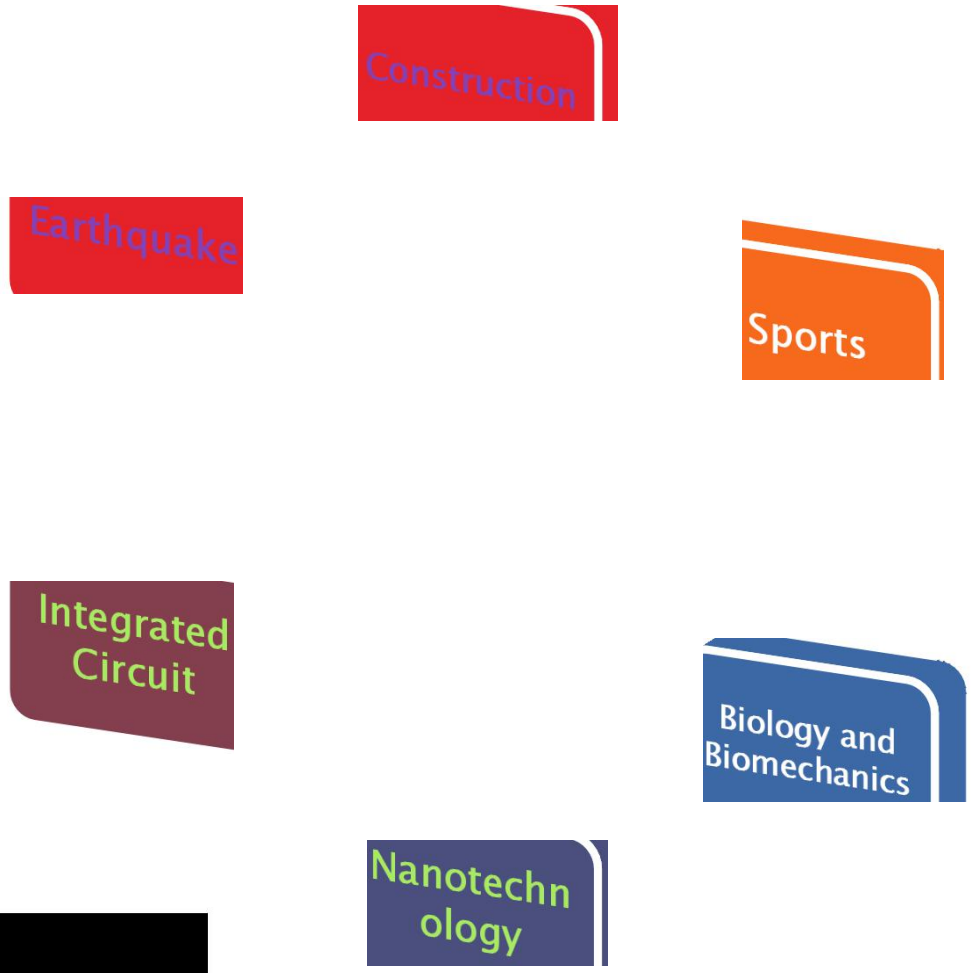
(2) Term examination: 80%

1. Before we start

In the following 3 years, you will learn more than 10 courses which are related to mechanics:

- ☆ **Linear Statics**
- ☆ **Thin structural elements**
- ☆ **Discrete structure dynamics**
- ☆ **Advanced dynamics of structure**
- ☆ **Finite element methods**
- ☆ **Applications of finite elements**
- ☆ **Aircraft and spacecraft loads**

Applications of Elasticity

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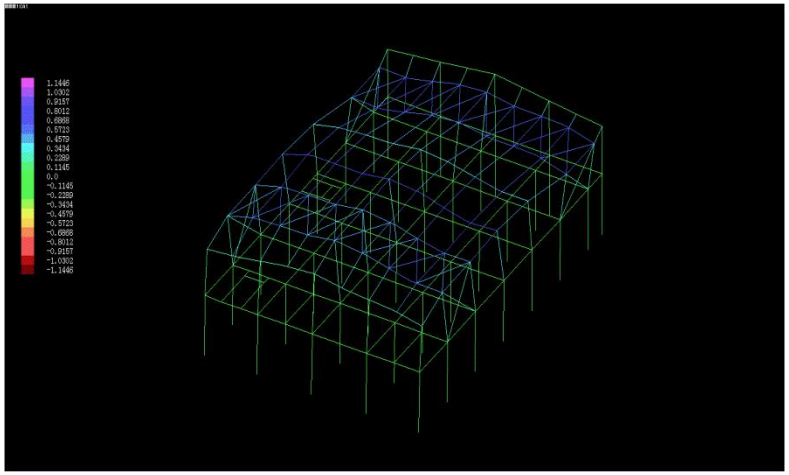
KEAKU快库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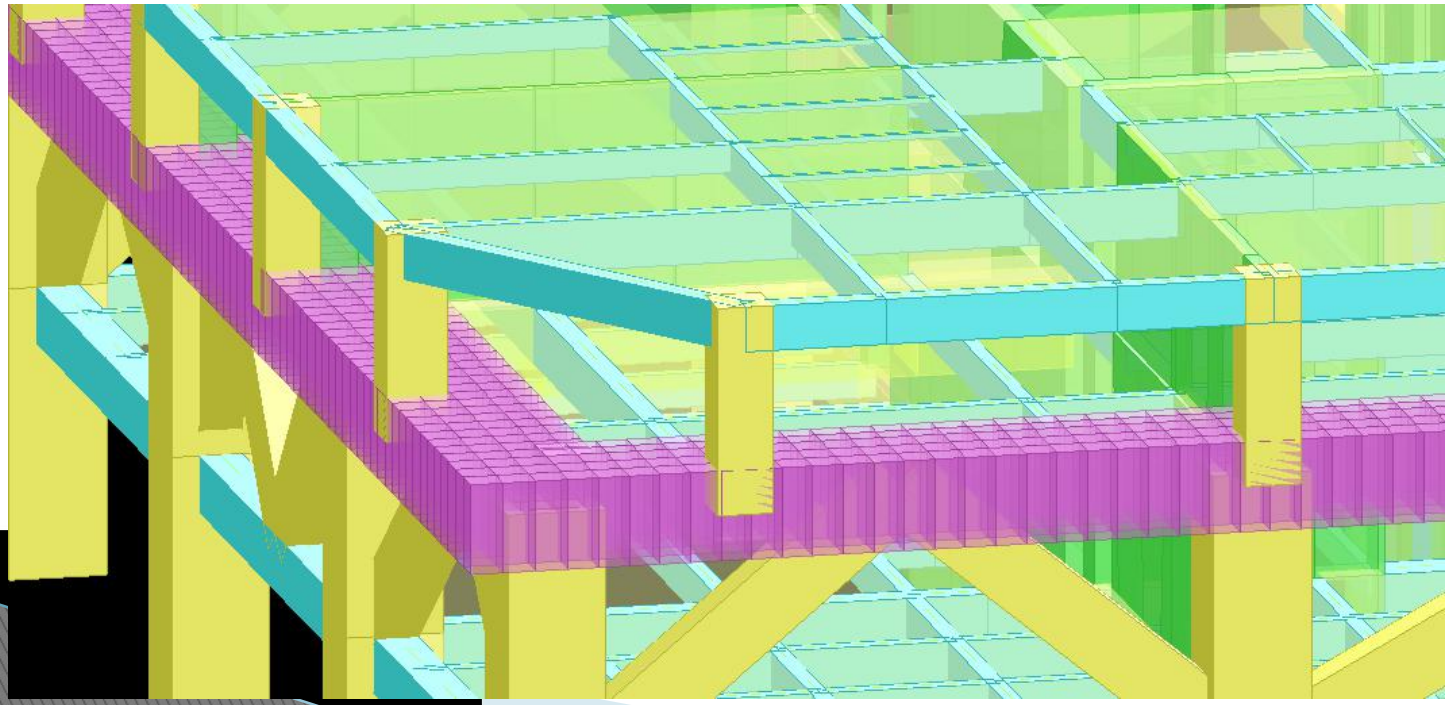
百度旅游


中国建筑


什么是转换层
就是这层的梁
sina 新浪乐居
house.sina.com.cn



2. Content of Elastostatics

-What is it?

Generally, mechanics is a subject which studies regulations of object's mechanical motion.

Elasticity, or elastic theory, is to study stress, strain, and displacement of an elastomer caused by foreign loads or temperature change.

★ looking for the stress, strain, and displacement;

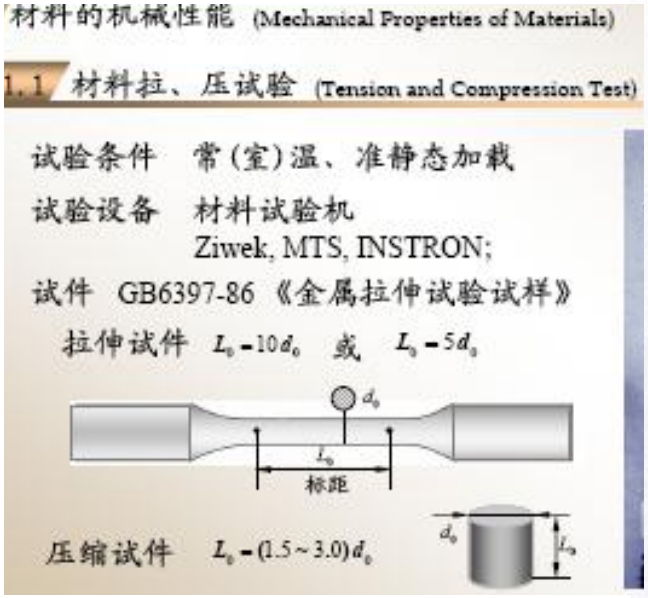
★ research object is an elastomer;

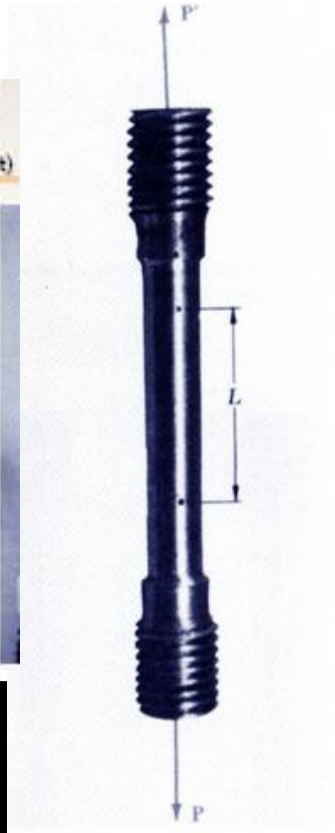
★all of these are resulted from foreign loads or temperature change

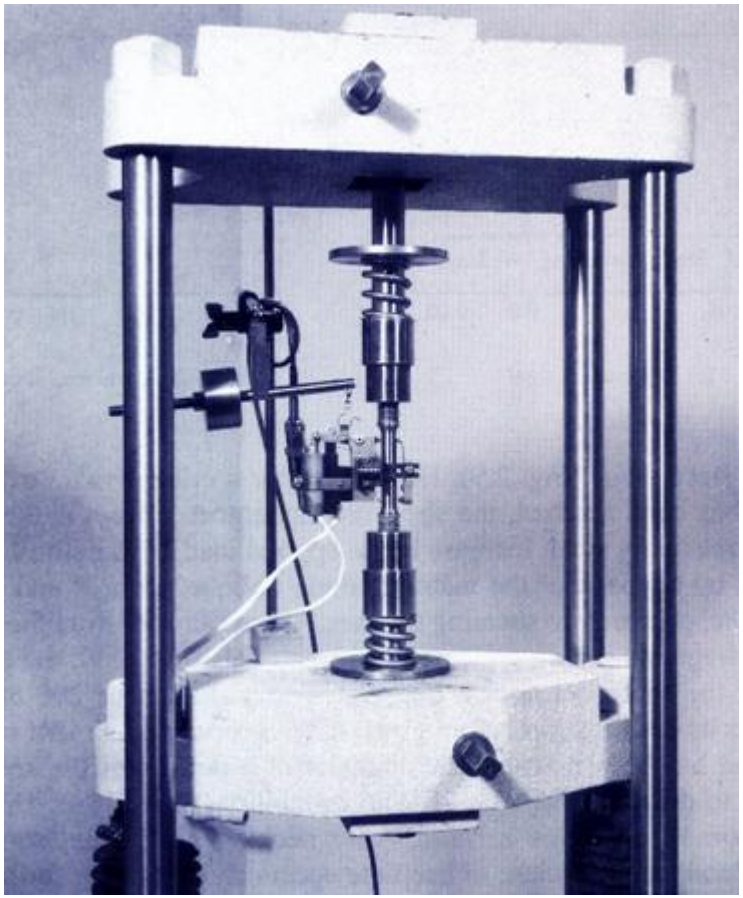
-Its relations with physics and classic mechanics (rational mechanics)

☆ we consider all objects as rigid or particle in classic mechanics.

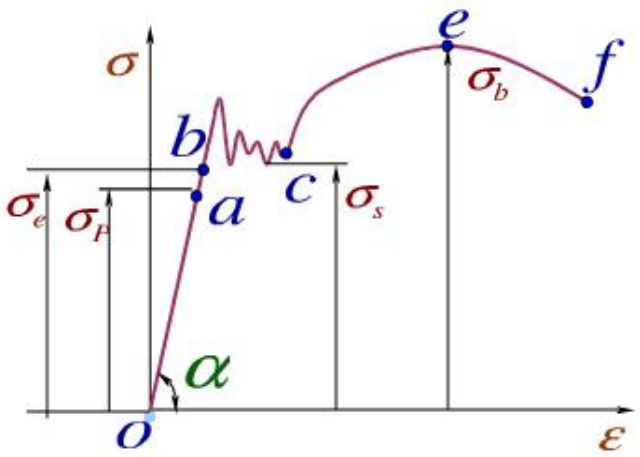
STRESS-STRAIN TESTING（应力－应变曲线拉伸试验）







yield strength
屈服应力
屈服强度



2、屈服阶段bc（失去抵抗变形的能力）

σ_s — 屈服极限

3、强化阶段ce（恢复抵抗变形的能力）

σ_b — 强度极限

4、局部径缩阶段ef

明显的四个阶段

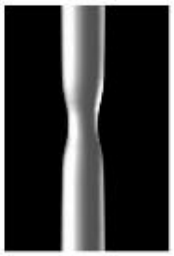
1、弹性阶段ob

σ_P — 比例极限

σ_e — 弹性极限

$\sigma = E\varepsilon$

$E = \frac{\sigma}{\varepsilon} = \tan\alpha$



ε

$+ \varepsilon^p$

Flow stress
流动应力

Strain hardening
加工(应变)硬化

Bauschinger effect

Strain-rate sensitivity (m)

Strain hardening exponent (n)

（任务）解决杆件的强度、刚度、稳定性问题。

Mech. Mater.- Stresses, strain and deformation, mechanical properties, failure criterion for bars under loads including thermal load.

Strengthen, rigidity and stability of loaded bars.

Struc. Mech. Stresses, strain and deformation, displacements for bars structure under loads including thermal load.

Strengthen, rigidity and stability of loaded bars structure.

Elastic mech. Stresses, strain and deformation, displacements for elastic objects under loads including thermal load.

Strengthen, rigidity and stability of loaded elastic objects.

Konwledge involved in:

[2rd] Stress in elastic solid

[3rd] Linear solid strain

[4th] Elastic linear isotropic Hooke's law

[5th] Elastostatic methods

[6th,7th] Analytical methods in elastic plane problems

[8th] Experimental elastic methods

- How we do?

Hypothetically, we split an object with a plane to achieve a section. On this section, load distribution on a point is studied. Enlarging this point, an infinitesimal-hexahedron that calls micro unit is used to indicate the point. Considering the loads on the cut part, balance equations can be written down as statics.

Sometimes, experimental methods and engineering computation methods are more important than analytical ones.

2. Basic concepts of elasticity

-**External force**: Force issued by other objects (not by object studied)

☆ It is divided to two kinds: volume force and surface force.

a. Volume force (because of mass) - In an elastomer, volume force is distributed according to its volume, such as gravity, and inertia force.

b. Surface force (because of touch) – surface force is distributed on the surface of an object, such as pressure of wind and liquids.

$$\vec{F} = \lim_{\Delta V \to 0} \frac{\Delta \vec{F}_b}{\Delta V} [\text{Force}] \cdot [\text{Length}]^{-3} \qquad (1.1)$$

$$\vec{f} = \lim_{\Delta S \to 0} \frac{\Delta \vec{F}_s}{\Delta S} [\text{Force}] \cdot [\text{Length}]^{-2} \qquad (1.2)$$

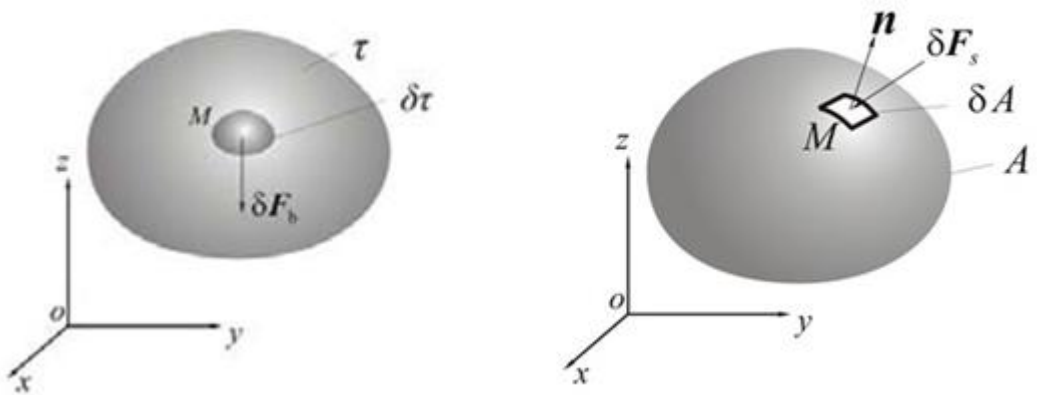
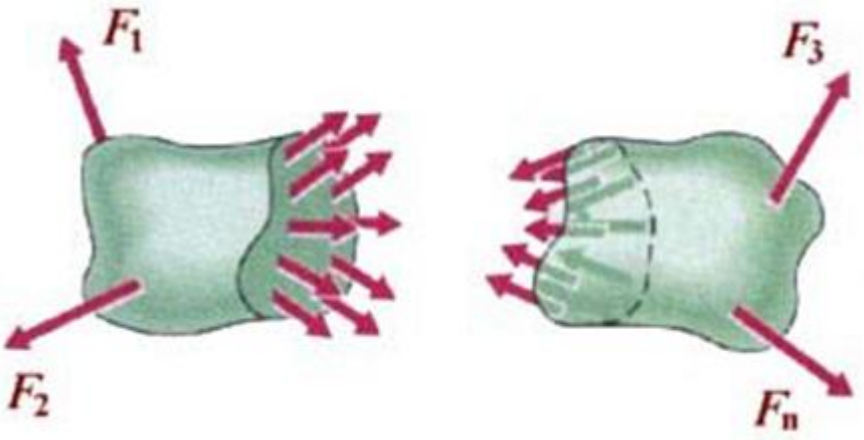


Figure1.2 Two kinds of loads

-Internal force and Stress

Force issued by a part of studied object towards other parts.

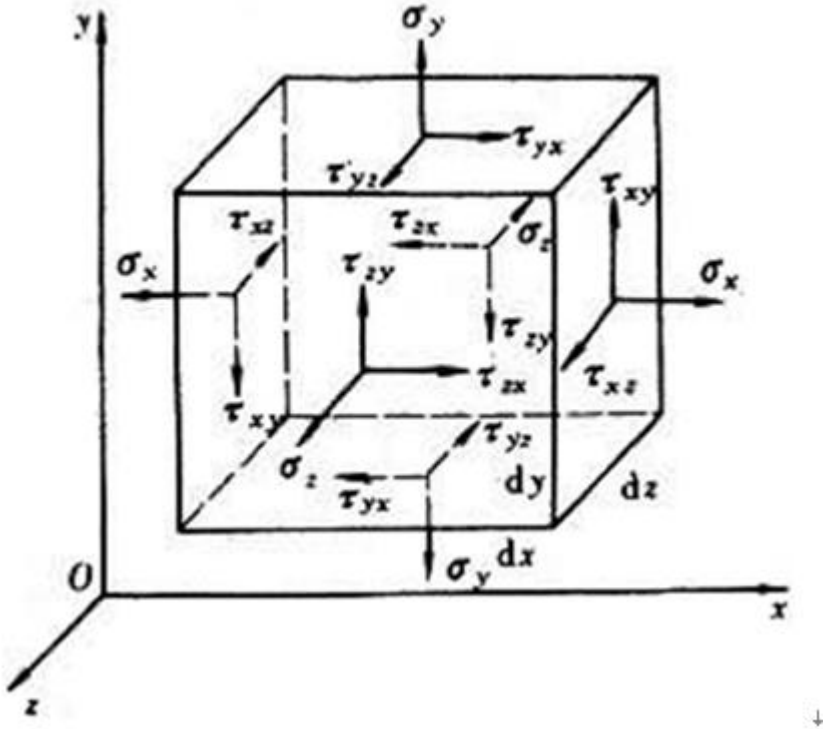
To descript distribution of internal force on a section, a limit equation is used to express the "internal force density" at a point, which is called **stress**.



Internal force and stress

$$\vec{s} = \lim_{\Delta A \to 0} \frac{\Delta \vec{Q}}{\Delta A} [\text{Force}] \cdot [\text{Length}]^{-2} \qquad (1.3)$$

Because of uncertain section direction, values of stress are different. To analyze and express stress state of a point, an infinitesimal unit is used.



An infinitesimal unit

-Deformation and Strain

Deformation refers to changes of dimension or shape of an object. To express deformation of an infinitesimal unit, normal strain and shear strain are defined to descript relative deviation of dimension and shape of a point.

-Displacement

Position change of a point in an object calls displacement. It is a result of force.

3.Basic assumptions of elasticity

-Continuity

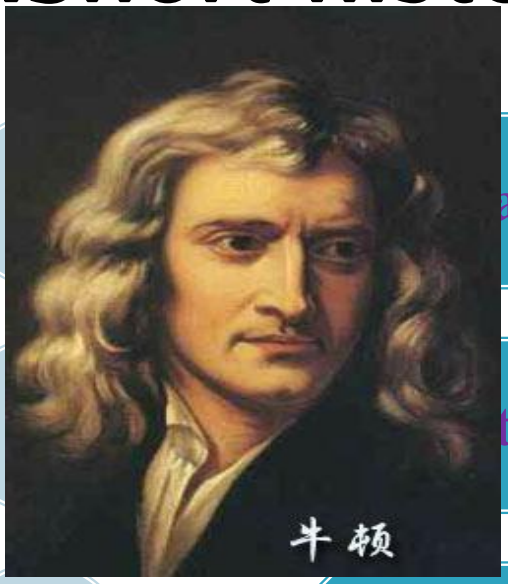
- Absolute elastic body

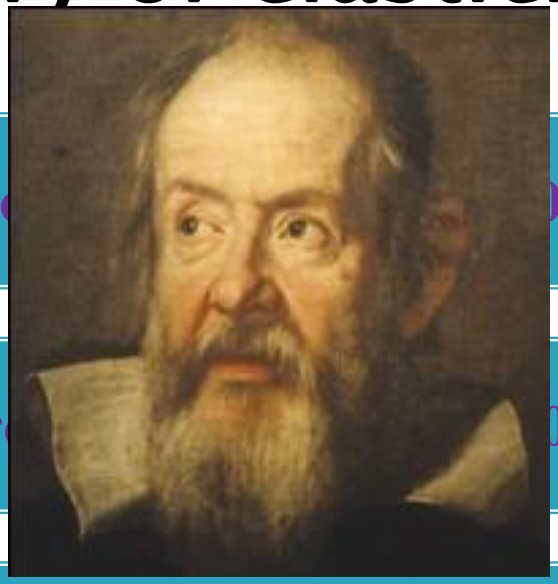
-Uniformity

-Isotropism

-Hypothesis of small deformation

4.Short history of elasticity(Mechanics)






伯努利，D.