Fluids, Thermodynamics, Waves, and Optics
Overview of Course
Fluids

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De Anza College

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Overview of the Course

There are 4 main sections to this course.

Topics

- fluids
- thermodynamics
- waves
- light and optics

Overview of the Course: Textbook Topics

Book

- Physics for Scientists and Engineers, 9th Edition, Serway & Jewett

What we will cover

- Chapter 14, fluids
- Chapters 19-22, thermodynamics
- Chapter 15-18, waves
- Chapter 35-38, light and optics

Overview of the Course

Other Books

- Fundamentals of Physics Extended, Halliday, Resnick, and Walker
- Feynman Lectures on Physics
- Physics for Scientists and Engineers, Knight

Assignments

- Collected homework problems on worksheets.
- Uncollected homework problems from the textbook. (You still need to do them.)
- Read the textbook.
- You will need to spend time on your own thinking through concepts and reading.
- You will need to make time to work on problems outside of class and discuss with others.

Useful Survival Trick

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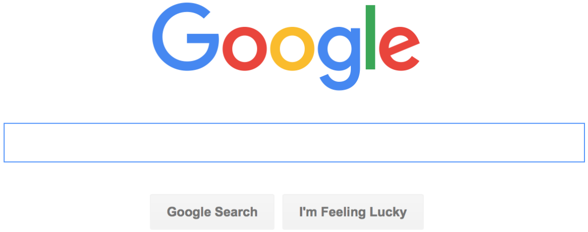

When you get stuck, use a search engine.

Other Resources

Resources for when you have questions

- Me. You can email me, ask me before or after class, or come to my office hours. **T, Th 10:30-11:20am**

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- The Math & Science Tutorial Center.

Where to look for course materials

- My website on the De Anza Physics page. **http://nebula2.deanza.edu/~lanasheridan/index.html**
- As a backup: Course Studio.

Overview of the Course

Evaluation

- quizzes (8%)
- 3 Tests ($6\% + 10\% + 10\% = 26\%$)
- Final exam (30%)
- 4 collected HWs (16%)
- Labs (20%)

Other Assignments

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Overview of the Course

Evaluation

Projected Grading Scheme:

$$
\begin{aligned}
95\% \rightarrow 100\% \quad &= A+ \\
88\% \rightarrow 94\% \quad &= A \\
85\% \rightarrow 87\% \quad &= A- \\
82\% \rightarrow 84\% \quad &= B+ \\
73\% \rightarrow 81\% \quad &= B \\
70\% \rightarrow 72\% \quad &= B- \\
67\% \rightarrow 69\% \quad &= C+ \\
58\% \rightarrow 66\% \quad &= C \\
46\% \rightarrow 57\% \quad &= D \\
0\% \rightarrow 45\% \quad &= F
\end{aligned}
$$

Overview of the Course

Note about presentation of work

- For each problem make sure your method is clear. Draw a diagram, define coordinates, if needed!
- If there is an equation or principle you are using, write it out at the start of your solution.
- Underline, box, highlight, or unambiguously emphasize the answer.
- If the reasoning is not clear, the answer is not correct.
- Give your answers to a reasonable number of significant figures.

Overview of the Course

Note about collected assignments

- If you cannot come to class on a due date, email me the assignment and bring the hard copy to the next class.
- If you are ill, or will have a problem handing in an assignment on time, come talk to me **before** the due date.

Fluids, Thermodynamics, and Optics

Imagine yourself in the world of 1700.

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What changed?

We learned a lot about fluids and thermodynamics.

Fluids, Thermodynamics, and Optics

Fast forward to 1900. Electromagnetic theory, thermodynamics, statistical mechanics were well-developed.

This allowed the steam engine and the industrial revolution.

Fluids and the effect of heating gases were well enough understood to allow manned hot air balloons by the 1780s and the Wright brothers to attempt powered fight in 1912.

Fluids, Thermodynamics, and Optics

However, there were still a few problems for physics.

Kelvin:

"The beauty and clearness of the dynamical theory, which asserts heat and light to be modes of motion, is at present obscured by two clouds. I. The first came into existence with the undulatory theory of light, and was dealt with by Fresnel and Dr Thomas Young; it involved the question, How could the earth move through an elastic solid, such as essentially is the luminiferous ether? II. The second is the Maxwell-Boltzmann doctrine regarding the partition of energy."

Fluids, Thermodynamics, and Optics

As for optics, the use and manufacture of lenses has been known since ∼750 BCE.

Many new optical devices, and a better understanding of light and waves were developed in the 1600s.

20th century progress allowed for the laser, optical drives, antireflective coatings, optical fibers, Doppler cooling, control of individual atoms, and advances in medical technology.

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- Why is the sky bright during the day? Why is the daytime sky blue?

This Course

Goals:

- be able to answer those types of conceptual questions
- know how to use theory to solve problems
- understanding principles and how they apply to technology

Quick Reminder: What is Physics?

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Model

A simplified description of a system and its interactions that includes only what is necessary to make predictions.

Fluids

In 4A we talked about the motion of rigid objects. They could translate or rotate.

Fluids, on the other hand, deform.

The methods we looked at for describing forces and motion of rigid objects need to be extended to deal with fluids.

Fluids

Matter can be in one of four states:

- solid
- liquid
- gas
- plasma

States of Matter

Solids

have definite shape and volume.

Liquids

have definite volume, but can flow and change shape.

Gases

have neither definite volume or definite shape.

In fact, whether we treat a particular substance as a solid or a liquid can depend on the *time scale* of interest.

Elastic Properties of Solids

All objects deform at least somewhat under forces.

Internal forces within the objects may resist these changes in shape or size.

Quantities that describe the response of the object to the external forces are called **elastic moduli**.

[1]See Serway & Jewett, Chapter 12 section 4.

Elastic Properties of Solids

We will define 3 kinds of **elastic modulus** in terms of:

Stress

the external force acting on an object per unit cross-sectional area

$$F/A$$

Strain

the fractional amount of change in shape of the object or material

For each:

$$\text{elastic modulus} = \frac{\text{stress}}{\text{strain}}$$

[1]See Serway & Jewett, Chapter 12 section 4.

Elastic Properties of Solids

$$\text{elastic modulus} = \frac{\text{stress}}{\text{strain}}$$

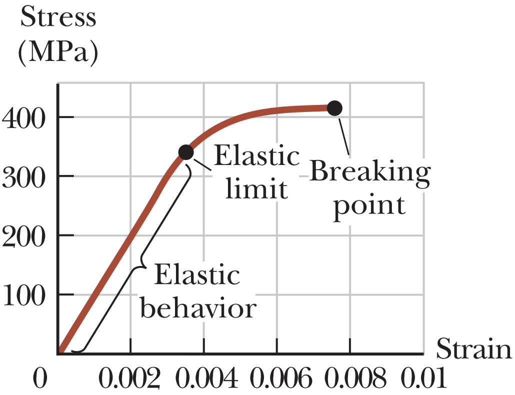
Units: Pascals, Pa. $1 \text{ Pa} = 1 \text{ N/m}^2$

Elastic modulus is similar to the spring constant, k, but the units are different. (k has units N/m.)

These moduli are defined for small stresses: that is the regime in which strain is directly proportional to stress (Hooke's law).

Elastic Properties of Solids

strain $\propto$ stress $\Rightarrow$ elastic modulus is a constant.



The different elastic moduli are properties of the material.

The values can be looked up in a table.

[1]Graph from Serway & Jewett, 9th ed, page 374.

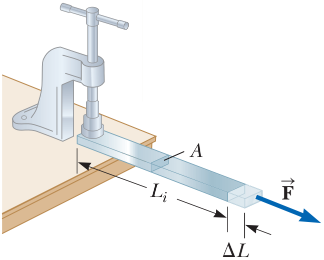
Young's Modulus: Length Elasticity

Young's modulus, Y, is a measure of the resistance of a solid to a change in its length.

$$Y = \frac{F/A}{\Delta L/L_i}$$

where

- F/A is the **tensile stress**: F points along the direction of the area vector, perpendicular to the surface F os applied to.
- $\Delta L/L_i$ is the **tensile strain**: ΔL is the change from the initial length L_i.



Young's Modulus Example

The Young's modulus of steel is $Y = 20 \times 10^{10}$ N/m^2.

Suppose the tension in a cable is 940 N. What diameter should a 10-m-long steel cable have if we do not want it to stretch more than 0.50 cm under these conditions?

[1]Based on example 12.5, page 376, Serway & Jewett, 9th ed.

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A &= \frac{F\,L_i}{Y(\Delta L)} \\
\frac{\pi d^2}{4} &= \frac{F\,L_i}{Y(\Delta L)} \\
d &= \sqrt{\frac{4F\,L_i}{\pi Y(\Delta L)}}
\end{aligned}
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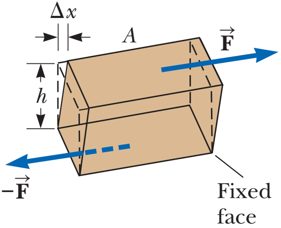
Shear Modulus: Shape Elasticity

Shear modulus, S, is a measure of the resistance to motion of parallel layers within a solid.

$$Y = \frac{F/A}{\Delta x/h}$$

where

- F/A is the **shear stress**: F is a tangential force, parallel to the surface F os applied to.
- $\Delta x/h$ is the **shear strain**: Δx is the distance the face is displaced and h is the perpendicular distance between faces.



Summary

- content of the course
- states of matter
- elastic moduli

Test Tuesday, April 17, in class.

Collected Homework TBA

(Uncollected) Homework

- Get the textbook: Physics for Scientists and Engineers, 9th Edition, Serway & Jewett
- Ch 12, onward from page 382, Obj Ques: 9; Probs: 29, 33.
- Read Ch 14.