Scope of this course

- Prerequisites:
  Introduction to Structures and Design (SE1)
  Statics (SE101A or equivalent)
  Solid Mechanics (SE110A or equivalent)

- What I expect:
  By the end of the quarter (actually, shortly after the midterm), you should understand structural properties of materials, and know how to choose materials according to functional requirements.

- What you should expect:
  Homework, Midterm, Final
Course Details

- Instructor: Prof. Yu Qiao
  Office: SME 442G
  Office Hours
  Phone: 858-534-3388

- Course Website –
  [http://mmrl.ucsd.edu/Courses/SE104/](http://mmrl.ucsd.edu/Courses/SE104/)

- TA
  Office Hours
  Homework

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Course Details

- Text Book: Ashby’s book (required)
- Material: Handouts
  Covered in class
  Homework assignments
  Text book

- Reference Book (suggested):
Course Structure

- Homework Assignments (10%)
- Class Participation (10%)
- Midterm (35%)
  - Final (45%)
- Students who get the average score will receive “B” (or “B+”, depending on the class performance); the interval between adjacent levels is 0.3 to 0.5 sigma

Course Details

- From the 2nd week, popup questions will be given “randomly”, as a part of the classroom discussion
- iClicker is required
- Full participation in all the popup questions = 10 points
- >70% correct answers ➔ bonus points: 2
  100% correct answers ➔ bonus points: 3
Course Structure

Midterm:
Closed-book, closed-notes
1 (and only 1) cheat sheet:
   letter sized, one-sided

Final:
Comprehensive
Closed-book, closed-notes
2 cheat sheets: letter sized, one-sided

For the Lab Sessions (SE 104L)

- Students must download hand-outs prior to each lab/class; must understand the lab instruction before the lab begins.
- Team work: lab preparation, lab, lab report (group discussion, literature research, writing, proofreading – unified lab report, etc.)
- Correction factor
- Grading
- UCSD email
Lab Sessions

- Safety –by the Lab Manager
- Lab preparation
- In the first lab, you need to form the team for the rest of the quarter. There will be log-in sheets for each lab section.
- Academic integrity

Citations in Lab Reports

- Citations must be given throughout the text, wherever other people’s work is referred to.
- A complete list of references must be given at the end of the lab report
- The references for images (including cover images), figures, tables, data, etc. must be specific.
- If the reference is a book, give the page number.
- Failure in giving references appropriately can lead to investigation of plagiarism.
Engineering materials

*Materials*

- Relating to, derived from, or consisting of matter
- Relating to, or concerned with, physical rather than spiritual or intellectual things
- The elements, constituents, or substances of which something is composed, or can be made

-Websters New Collegiate Dictionary
History of Materials

Colored zones indicate man-made materials

Science & Engineering

- Materials Science:
  - Discipline involving the investigation of fundamental relationships between structure and properties of materials & development of new materials
  - Discovery, depth
Science & Engineering

- Materials Engineering:
  - Discipline involving the design and use of material on the basis of structure-property relationships
  - Invention, novelty

Common Material Properties

<table>
<thead>
<tr>
<th>General</th>
<th>Mechanical</th>
<th>Thermal</th>
<th>Electrical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Stiffness</td>
<td>Conductivity</td>
<td>Dielectric</td>
</tr>
<tr>
<td>Density</td>
<td>Strength</td>
<td>Diffusivity</td>
<td>Constant</td>
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<tr>
<td></td>
<td>Toughness</td>
<td>Heat Capacity</td>
<td>Conductivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expansion</td>
<td></td>
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</tbody>
</table>

- Collectively measures the complexity of processing and availability

- Magnetic:
  - Remanence
  - Saturation
  - Magnetization

- Optical:
  - Refraction
  - Absorption

- Chemical:
  - Corrosion
  - Resistance
**Mechanical Properties**

- **E** - elastic modulus
- **σ_y** - yield strength
- **K_{1c}** - fracture toughness

A plastic strip exhibits a large deflection (without damage) under bending forces:

- **Stiff vs. flexible**
  - Stiffness of the structure
  - Stiffness of the materials that carry the load
**Mechanical Properties**

An iPhone 6 is permanently bent (damaged):

- **Strength of the structure** → **Strength of the material at the damaged area**

  **Strong vs. weak**

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**Mechanical Properties**

An iPhone 6 is fractured (final failure happens):

- **Toughness of the structure** → **Toughness of the material at the cracking area**

  **Tough vs. brittle**
**Thermal Properties**

- $T_{\text{max}}$ – limiting temperature for engineering applications
- $C_p$ – heat capacity
- $\lambda$ - conductivity
- diffusivity $\propto \lambda / C_p$

**Electrical, Magnetic, and Optical Properties**

- $\varepsilon_D$ – dielectric constant
- 'hard' magnet - permanently magnetized
- 'soft' magnet – can be magnetized and demagnetized
Chemical Properties

Intrinsic resistance of a material in a given environment

Scale of measurement:
1 (very bad) – 5 (very good)

Structure and Properties

Processing ➔ Structure ➔ Properties ➔ Performance

- Mechanical
- Electrical
- Thermal
- Magnetic
- Optical
- Deteriorative
**Design-limiting Properties**

Properties that determine the suitability of a material based on design requirements.

For the plane, strength, stiffness and toughness are design limiting – if any of the three are too low, the plane will not fly.

![Figure 1.2](image_url)