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 (12.5%)
- Popup Questions (7.5%), bonus points (up to 2)
- 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 = 7.5 points
- >50% correct answers ➔ bonus point: 1
  >75% correct answers ➔ bonus point: 2
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
Imagination

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

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

- Hexcel: Use different materials to increase efficiency & to meet new functional requirements

Create new things…
Common Material Properties

- **General**
  - Cost
  - Density

- **Mechanical**
  - Stiffness
  - Strength
  - Toughness

- **Thermal**
  - Conductivity
  - Diffusivity
  - Heat Capacity
  - Expansion

- **Electrical**
  - Dielectric Constant
  - Conductivity

- **Magnetic**
  - Remanence
  - Saturation Magnetization

- **Optical**
  - Refraction
  - Absorption

- **Chemical**
  - Corrosion Resistance

Collectively measures the complexity of processing and availability

**Mechanical Properties**

- $E$ - elastic modulus
- $\sigma_y$ - yield strength
- $K_{1c}$ - fracture toughness

Figure 1.2
**Mechanical Properties**

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

- 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
**Mechanical Properties**

An iPhone 6 is fractured (final failure happens):

*Toughness of the structure →

Toughness of the material at the cracking area

**Thermal Properties**

$T_{\text{max}}$ – limiting temperature for engineering applications

$C_p$ – heat capacity

$\lambda$ - conductivity

Diffusivity $\propto \frac{\lambda}{C_p}$
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