EGN3365: Introduction to Materials Science & Engineering

Course Objective...

Introduce fundamental concepts in Materials Science and Engineering

You will learn about:

• material structure
• how structure dictates properties
• how processing can change structure

This course will help you to:

• use materials properly
• realize new design opportunities with materials
LECTURES

Lecturer: Jiuhua Chen

Time: Mon. Wed. Fri. (Tutorial) 5:00-6:15PM

Location: EC2410/EC1112

Activities:
• Present new material
• Announce reading and homework
• Quizzes and midterm*

*No make-ups, (One optional accumulated make-up quiz may be given to make up the grade at the end of the semester.

Quizzes may or may not be announced.
Tests: one 8 ½ X 11 hand written note sheet (both sides) may be used during each test (but not during quizzes). Otherwise, tests and quizzes will be closed book.
TEACHING ASSISTANTS

Name
Md Hasnine

E-mail
hasnine01@yahoo.com

Teaching Assistants will

• solve the selected home work problems
• give you other practice problems
• go over the some of the portion of the preceding lectures.
• have office hours to help you with course material and problem sets.
Office Hours

EC 3471-**Mon** and **Wed**: 2:00-3:30 PM, other times by appointment via email

VH 140 – by appointment.

**TA Office Hours**

To be announced
COURSE MATERIALS

Required text:

- *Materials Science and Engineering: An Introduction*
Homework

Homework will be assigned but not collected. The solutions to problems will be discussed during Tutorial session.
GRADING

2 – Exams @ 35 points  
6 quizzes @ 5 points  
Total Points

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Point Range</th>
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<th>Letter Grade</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>above 90</td>
<td>A-</td>
<td>86 – 90</td>
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<tr>
<td>B+</td>
<td>82 – 86</td>
<td>B</td>
<td>78 – 82</td>
<td>B-</td>
<td>74 – 78</td>
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<tr>
<td>C+</td>
<td>70 – 74</td>
<td>C</td>
<td>67 – 70</td>
<td>C-</td>
<td>64 – 67</td>
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<tr>
<td>D+</td>
<td>61 – 64</td>
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<td>58 – 61</td>
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Letter Grade Point Range Letter Grade Point Range Letter Grade Point Range

A above 90 A- 86 – 90
B+ 82 – 86 B 78 – 82 B- 74 – 78
C+ 70 – 74 C 67 – 70 C- 64 – 67
D+ 61 – 64 D 58 – 61 F Below 58

70
30
100
# READING SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject</th>
<th>Reading</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction; atomic bonding</td>
<td>Ch.1, Ch.2</td>
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<tr>
<td>2</td>
<td>Crystal structure, X-ray diffraction</td>
<td>Ch.3</td>
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<td>3</td>
<td>Defects in Solids, Dislocations</td>
<td>Ch.4</td>
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<td>4</td>
<td>Diffusion</td>
<td>Ch.5</td>
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<td>5</td>
<td>Mechanical Properties</td>
<td>Ch.6, Ch.7</td>
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<tr>
<td>6</td>
<td>Dislocations, Failure Mechanisms</td>
<td>Ch.7, Ch.8</td>
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<td>7</td>
<td>Phase Diagrams</td>
<td>Ch.9</td>
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<tr>
<td>8</td>
<td>Microstructure, TTT diagram</td>
<td>Ch.10</td>
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<td>9</td>
<td>Microstructure, Thermal Processing</td>
<td>Ch.10, Ch.11</td>
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<td>Thermal processing, Metal alloys</td>
<td>Ch.11</td>
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<td>11</td>
<td>Ceramics and glasses/polymer</td>
<td>Ch.12, Ch.13</td>
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<td>12</td>
<td>Polymers</td>
<td>Ch.13, Ch.14</td>
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<tr>
<td>13</td>
<td>Composites, Electrical properties</td>
<td>Ch.15, Ch.16</td>
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<td>14</td>
<td>Electrical Properties</td>
<td>Ch.16, Ch.18</td>
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<td>15</td>
<td>Electrical Properties, Review</td>
<td>Ch.18</td>
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**Lectures:** will highlight important portions of each chapter.
Academic Integrity

*Florida International University is a community dedicated to generating and imparting knowledge through excellent teaching and research, the rigorous and respectful exchange of ideas, and community service. All students should respect the right of others to have an equitable opportunity to learn and honestly to demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the Student Handbook.*
Chapter 1 - Introduction

- What is materials science/engineering?
- Why should we know about it?

- Materials drive our society
  - Stone Age
  - Bronze Age
  - Iron Age
  - Now?
    - Silicon Age?
    - Polymer Age?
Structure, Processing, & Properties

Name: diamond
Composition: C
Structure: cubic
Forming condition: high P & T
Property: hard

Name: graphite
Composition: C
Structure: hexagonal
Forming condition: ambient
Property: soft
Structure, Processing, & Properties

- **Properties** depend on **structure**
  ex: hardness vs structure of steel

Data obtained from Figs. 10.30(a) and 10.32 with 4 wt% C composition, and from Fig. 11.14 and associated discussion, *Callister 7e*. Micrographs adapted from (a) Fig. 10.19; (b) Fig. 9.30; (c) Fig. 10.33; and (d) Fig. 10.21, *Callister 7e*.

- **Processing** can change **structure**
  ex: structure vs cooling rate of steel

<table>
<thead>
<tr>
<th>Cooling Rate (°C/s)</th>
<th>Hardness (BHN)</th>
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<tr>
<td>0.01</td>
<td>100</td>
</tr>
<tr>
<td>0.1</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>300 (b)</td>
</tr>
<tr>
<td>10</td>
<td>400 (c)</td>
</tr>
<tr>
<td>100</td>
<td>500 (d)</td>
</tr>
<tr>
<td>1000</td>
<td>600</td>
</tr>
</tbody>
</table>

30 µm
Types of Materials

• **Metals:**
  – Strong, ductile
  – high thermal & electrical conductivity
  – opaque, reflective.

• **Polymers/plastics:** Covalent bonding $\rightarrow$ sharing of e’s
  – Soft, ductile, low strength, low density
  – thermal & electrical insulators
  – Optically translucent or transparent.

• **Ceramics:** ionic bonding (refractory) – compounds of metallic & non-metallic elements (oxides, carbides, nitrides, sulfides)
  – Brittle, glassy, elastic
  – non-conducting (insulators)
The Materials Selection Process

1. Pick Application  → Determine required Properties
   Properties: mechanical, electrical, thermal, magnetic, optical, deteriorative.

2. Properties  → Identify candidate Material(s)
   Material: structure, composition.

3. Material  → Identify required Processing
   Processing: changes structure and overall shape
   ex: casting, sintering, vapor deposition, doping forming, joining, annealing.
ELECTRICAL

- Electrical Resistivity of Copper:

- Adding “impurity” atoms to Cu increases resistivity.
- Deforming Cu increases resistivity.

Adapted from Fig. 18.8, Callister 7e.
SUMMARY

Course Goals:

• Use the right material for the job.

• Understand the relation between properties, structure, and processing.

• Recognize new design opportunities offered by materials selection.