**Intended Audience:** An introductory undergraduate level course for all interested FENS students; this is a core elective for BIO, MAT, ME and MS programs.

**Scope:** To provide the fundamentals of how interactions and structure at the atomic scale lead to material properties observed at the macroscopic scale and to introduce the fundamental thermodynamic/kinetic concepts operating on the structure for the design and implementation of materials with novel functions.

**Aims:** To equip the students with a basic understanding of “materials science” so that they can (i) relate the atomic scale interactions to the structure of the material observed at the macroscopic scale; (ii) interrelate the mechanical, thermal, electrical, magnetic and optical properties of materials; (iii) explain the phase behavior and how thermodynamics and kinetics may be used to manipulate the observed phases; (iv) differentiate between novel materials such as polymers, ceramics, composites based on their properties.

**Instructors:**
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- Ali Tufani – office: L003; phone: 2345; e-mail: alitufani@sabanciuniv.edu

**Hours:**
- **Lecture** – W 10:40 – 12:30 (FENS G077); F 10:40 – 11:30 (FENS G032)
  - R 8:40 – 9:30 section B1-B3
- **Office Hours** –
  - Ece Alpaslan: Thursday: 9.40-10.30 and Friday: 11.40-12.30
  - Pelin Güven: Tuesday: 13.40-14.30 and Friday: 11.40-12.30
  - Parveen Qureshi: Wednesday: 10.40-11.30 and Friday: 10.40-11.40
  - Ezgi Dündar Tekkaya: Tuesday: 9.40-10.30 and Wednesday: 9.40-10.30


**Supplementary material:** Materials Science and Engineering: An Introduction by Callister Properties of Materials by Mary Ann White

**Evaluation** will be based on two midterms (25 % each), final exam (35 %), labs & recitations (15 %).

**Exam dates:** Exam 1 – Nov. 6; Exam 2 – Dec. 19; Final Exam– to be announced.

**Brief outline:**

<table>
<thead>
<tr>
<th>Structure</th>
<th>General concepts and definitions. Understanding interactions in materials at the atomic scale.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystals (ch 3)</td>
<td>Symmetry. Arrangement of particles inside crystals – the 14 lattice types. Lattice positions, directions and planes; fundamentals of x-ray diffraction</td>
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<tr>
<td>Imperfect structures (ch 4)</td>
<td>Crystal defects and amorphous structures</td>
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<tr>
<td>Diffusion (ch 5)</td>
<td>Thermal activation of processes. Time dependent changes.</td>
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<thead>
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<tr>
<td>Mechanical Properties (ch 6, 8)</td>
<td>2 weeks</td>
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<tr>
<td>Thermal Properties (ch 7)</td>
<td>Response of materials to the application of heat: Heat capacity, thermal expansion, thermal conductivity</td>
</tr>
<tr>
<td>Electrical, optical and magnetic properties (ch 13)</td>
<td>Properties that make materials interesting for novel applications: Electrical, optical and/or magnetic sensitivity, with emphasis on electrical conductivity</td>
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<table>
<thead>
<tr>
<th>Behavior and Design</th>
<th>The phase rule, the lever rule, stability. Eutectic diagrams. Development of microstructure during slow cooling.</th>
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<tbody>
<tr>
<td>Phase diagrams (ch 9)</td>
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<td>Time-dependent phase transformations (ch 10)</td>
<td>Transformation on a temperature-versus-time plot (TTT diagram)</td>
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<tr>
<td>Nanomaterials</td>
<td>Novel materials operating at the nanoscale</td>
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### Timetable of events in ENS 205

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
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<th>Event</th>
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<tbody>
<tr>
<td>26/09</td>
<td>Wed</td>
<td>Ch 1 &amp; 2</td>
<td>02/11</td>
<td>Fri</td>
<td>Ch 5</td>
<td>05/12</td>
<td>Wed</td>
<td>Ch 13</td>
</tr>
<tr>
<td>28/09</td>
<td>Fri</td>
<td>Ch 2</td>
<td>06/11</td>
<td>Tue</td>
<td><strong>Exam 1</strong></td>
<td>07/12</td>
<td>Fri</td>
<td>Ch 13</td>
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<tr>
<td>03/10</td>
<td>Wed</td>
<td>Ch 3</td>
<td>07/11</td>
<td>Wed</td>
<td>Ch 5</td>
<td>12/12</td>
<td>Wed</td>
<td>Ch 9</td>
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<tr>
<td>05/10</td>
<td>Fri</td>
<td>Ch 3</td>
<td>09/11</td>
<td>Fri</td>
<td>Ch 5</td>
<td>14/12</td>
<td>Fri</td>
<td>Ch 9</td>
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<tr>
<td>10/10</td>
<td>Wed</td>
<td>Ch 3</td>
<td>14/11</td>
<td>Wed</td>
<td>Ch 6</td>
<td>19/12</td>
<td>Wed</td>
<td><strong>Exam 2</strong></td>
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<tr>
<td>11/10</td>
<td>Thur</td>
<td><strong>Lab 1</strong></td>
<td>16/11</td>
<td>Fri</td>
<td>Ch 6</td>
<td>20/12</td>
<td>Thur</td>
<td><strong>Lab 3</strong></td>
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<td>12/10</td>
<td>Fri</td>
<td><strong>No class</strong></td>
<td>21/11</td>
<td>Wed</td>
<td>Ch 8</td>
<td>21/12</td>
<td>Fri</td>
<td>Ch 9</td>
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<tr>
<td>17/10</td>
<td>Wed</td>
<td>Ch 3/4</td>
<td>23/11</td>
<td>Fri</td>
<td>Ch 8</td>
<td>26/12</td>
<td>Wed</td>
<td>Ch 9</td>
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<tr>
<td>19/10</td>
<td>Fri</td>
<td><strong>No class</strong></td>
<td>28/11</td>
<td>Wed</td>
<td>Ch 7</td>
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<td>Ch 10</td>
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<tr>
<td>24-26/10</td>
<td>Term</td>
<td>Break</td>
<td>29/11</td>
<td>Thur</td>
<td><strong>Lab 2</strong></td>
<td>02/01</td>
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<td>Ch 10</td>
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<tr>
<td>31/10</td>
<td>Wed</td>
<td>Ch 4</td>
<td>30/11</td>
<td>Fri</td>
<td>Ch 7</td>
<td>04/01</td>
<td>Fri</td>
<td>Nanomtl’s</td>
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