ENS 205 Introduction to Materials Science (SPRING 23-24)

INSTRUCTOR: Emre Erdem, emre.erdem@sabanciuniv.edu

Office hours: 24h via WhatsApp, or by appointment face-to-face (Office G021; FENS) or Tuesday 16:30-17:00 (FENS LAB 2110)

Coordinator : ileyna Üvak (ileyna.uvak@sabanciuniv.edu)

TA's:
To be announced

Course Schedule:
Tuesday: 14:40 - 16:30 @ Room: FMANN 1099
Thursday: 16:40 - 17:30 @ Room: FENS G077
Fridays: Recit hours (sections will be announced later)

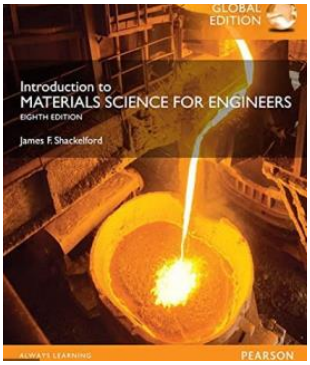
Participation (lecture): missing above 8 Sessions (will fail)

Participation (LAB): 2 mandatory LABS

Mondays: 1 Session & Thursdays: 1 Session

GRADING: %40 of MIDTERM + %50 of FINAL + %10 LAB exam (Attendance of 2 Mandatory Lab sessions)

Text Book: J. Schakelford



Intended Audience:

An introductory undergraduate level course for all interested FENS students especially for MAT, BIO, ME, and IE programs.

Scope:

To provide fundamentals of how interactions and structure at atomic scale lead to macroscopic properties and to introduce the fundamental thermodynamic/kinetic concepts operating on the structure for the design and implementation of materials with novel functions. The class will also give insight to what MAT Engineers do in industry.

Schedule / Content:

Week 1 / 3 hours

- General concepts and definitions
- Understanding interactions in materials at the atomic scale
- Functional Materials, How to make functional materials
- Why nanomaterials are important
- Broader / Social Impact of Materials Science
- Atomic bonding, Crystals, Classification of crystals

Week 2 / 3 hours

- Engineering Materials
- Crystals, Bonding, Failures, Primary bonding
- Symmetry
- Lattice positions, directions and planes; fundamentals of x-ray diffraction

Week 3 / 3 hours

- Secondary bonding (Hydrogen bonds, Van der Waals bond)
- Electronegativity, Polar crystals
- Lattice, Unit cell, Atomic packaging factors
- Arrangement of particles inside crystals

Week 4 / 3 hours

- Lattice positions, directions, and planes; fundamentals of x-ray diffraction
- Miller indices

Week 5 / 3 hours

- Defects, Dislocations
- Diffusion, Thermal activation of processes; time-dependent changes
- Arrhenius plot, Activation energy, Fick's Law

Week 6 / 3 hours

- Mechanical properties of materials
- The response of materials to mechanical changes: Stress-strain curves, Tensile test

- Elastic and plastic deformation; measurements by creep and stress relaxation

Week 7 / 3 hours

- Thermal properties of materials
- The response of materials to heat: Heat capacity, thermal expansion, thermal conductivity
- Debye Model, Dulong-Petit
- Failure analysis and Prevention, Ductile-to-Brittle transition, Experiments; failure analysis

Week 8 / 3 hours

- Phase diagrams
- The lever rule, stability. Eutectic diagrams.
- Development of microstructure during slow cooling

Week 9 / 3 hours

- Kinetics, Heat treatment
- Time-dependent phase transformations, Transformation on a temperature-versus-time plot (TTT diagram)
- Nucleation
- Development of microstructure during slow cooling
- Ferrous and non-ferrous materials
- Types of steel (stainless, cast, low carbon, mild etc..)

Week 10 / 3 hours

- Structural properties of polymers
- Thermoset and thermoplastic materials
- Additives, Metal Matrix Composites
- Electrical properties of materials

Week 11 / 3 hours

- Charge carriers, Hund rules
- Energy levels, Doping in semiconductors
- Electronic properties of Engineering materials
- Optical and magnetic properties

Week 12 / 3 hours

- Applications in Materials Engineering

MANDATORY LAB SESSIONS: (details will be given during the semester)

Crystallography LAB (WINDOWS COMPUTER/LAPTOP IS REQUIRED)

Mechanics LAB