"We may have to revise the course plan according to the countrywide reassessment to be made regarding higher education. This is expected to happen at the beginning of April. The content to be delivered is certain but the method of course delivery, the number and dates of exams, and some other details are subject to change."

ENS 205 Introduction to Materials Science (SPRING 22-23)

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)

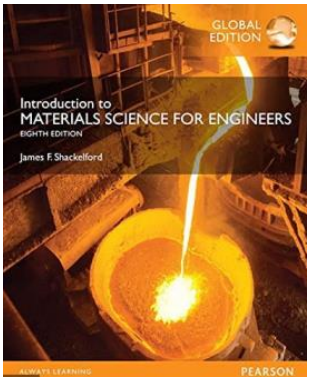
Course Schedule:
Tuesday: 14:40 - 16:30 @ Room: FENS G077
Thursday: 16:40 - 17:30 @ Room: FENS G077

Attendance: if you miss **12 lecture hours** you will fail

Midterm & Final dates: TBA, Physical

GRADING: %40 of MIDTERM + %60 of FINAL

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