Department of Materials Science and Engineering
Department of Mechanical Engineering
University of Maryland, College Park

ENMA 300/ENME 382 (Spring 2020): Introduction to Engineering Materials

Section 0301

Course Information

Focus: Materials selection based on: (1) fundamental behaviors; (2) ability to tailor performance to the application via processing and microstructure; (3) manufacturability; (4) reliability; and (5) sustainability.

Description: Structure, phase transformations, corrosion, and mechanical properties of metals, ceramics, polymers, and related materials. Materials selection and manufacturing processes for engineering applications.

Class Schedule: CHE2118; TuTh 11:00am - 12:15pm, section 0301

Textbook: Callister, William D., Jr., and Rethwisch, David G., Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Ed., John Wiley and Sons, 2015. **You will need WileyPLUS**.

You may purchase your textbook from the bookstore ISBN 9781119127550 (electronic version) or 9781119230403 (hardcopy) or directly from Wiley at http://www.wiley.com/WileyCDA/Section/id-829171.html (Links to an external site.)

MSE students should make sure that they purchase the entire book as they will use it again in ENMA 301.

Instructor: Dr. Liyang Dai-Hattrick

hattrick@umd.edu

Room 2125 CHE (Bldg. 90)

Office Hours: Tuesday 12:30PM~1:30PM; Wednesday 11:00 AM~1:00 PM; Thursday 12:30PM~1:30PM, and by appointment.

Office hour schedules for all TFs, TAs and Dr. Schwarm (Sections 0101) will be available. Students are welcome to attend office hours for any of the instructors, TAs or TFs.

To ask course-related questions, provide documentation for an excused absence, arrange a meeting for discussion of academic accommodation for an excused absence, or arrange a meeting for discussion of ADS accommodations, see Dr. Hattrick during office hours or contact her by email (hattrick@umd.edu) to arrange an appointment. Provid notification of an absence and documentation for an excused absence in writing by email.

TAs and TFs: These members of the teaching team will play an important role in the course, including office hours, grading, review sections, and other activities. Contact information for the TAs and TFs and their office hours will be posted separately on Canvas once everyone's semester schedules are finalized. If you have questions you may go to office hours for any of the instructors, TAs or TFs.

Communication: Communication between the teaching team and students will be via the Canvas course website and by UMD email account. It is the student's responsibility to check emails and monitor the site daily for announcements.

Other Course Sections: There will be close coordination among the sections of this course, but they are individually taught and there will be differences among them.

Inclement Weather: If more than one lecture is missed due to inclement weather causing the University of Maryland to close or open late, there will be a shortened make-up lecture on-line. Students will be responsible for any online content to the same degree as for the in-person lectures (w.r.t. test material, homework, etc.).

Course Description, Goals, and Expectations

Course Objectives

The main objective of this course is to understand the process-structure-property relationships in engineering materials and to be able to use this information in materials selection for engineering design. A student completing this course satisfactorily should be able to do the following.

1. Identify features of crystal structures and their relationship to physical, mechanical, thermal, and chemical properties of materials.
2. Understand the similarities and differences in the microstructure of metals, ceramics, polymers, biomaterials, and nano-materials; and how these relate to their properties.
3. Interpret features of binary phase diagrams and identify phase transformations.
4. Identify process-structure-property relationships in engineering materials; and understand how these apply to materials selection in specific engineering problems. Consider sustainability in materials selection.
5. Address basic concepts of engineering ethics.

Topics

0. Engineering ethics will be covered throughout the course and especially in the topic of material degradation.

I. Introduction - Chapter 1
1. Concept of process-structure-property relationships
2. Materials classifications based on structure and properties
3. Methodology for materials selection including sustainability issues

II. Atomic Structure and Interatomic Bonding - Chapter 2
1. Atomic Structure and the Periodic Table
2. Atomic Bonding in Solids
3. Effects of atomic bonding on Properties: Mechanical, Thermal, Electrical, Chemical, Sustainability

III. Structure of Crystalline Solids (metals and ceramics) - Chapter 3
1. Crystal Structures: Unit cells, common structures, lattice parameters, density calculations, crystal systems
2. Polymorphism: Carbon including fullerenes, carbon nanotubes, graphite, and graphene.
3. Crystallographic directions and planes
4. Glasses

IV. Polymer Structures - Chapter 4
1. Polymer molecules - mers, chemistry, common polymers
2. Molecular weight and its effect on properties
3. Molecular structure; configuration; and crystallinity
4. Thermoplastics and thermosets
5. Recyclability, biodegradability, availability, and sustainability

V. Defects and imperfections in solids (metals and ceramics) - Chapter 5
1. Point defects
2. Dislocations
3. Grain boundaries, phase boundaries, surfaces and microstructure

VI. Diffusion (metals and ceramics) - Chapter 6
1. Diffusion mechanisms
2. Steady-state diffusion
3. Factors that influence diffusion

VII. Mechanical Properties - Chapter 7
1. Concepts of stress and strain
2. Elastic and plastic deformations
3. Hardness

VIII. Deformation and Strengthening Mechanisms - Chapter 8
1. Dislocations, slip planes, slip directions and plastic deformation

2. Strengthening in metals
3. Recovery, recrystallization and grain growth

IX. Failure - Chapter 9
1. Fracture concepts (e.g. ductility, brittleness, microstructures)
2. Fracture mechanics
3. Fatigue: the S-N curve
4. Creep
5. Designing for robustness – safety margins, failure statistics, sustainability
6. Reliability, accelerated testing, and sustainment

X. Phase Diagrams and Phase Transformations - Chapters 10 and 11
1. Basic concepts
2. Equilibrium phase diagrams (metals and ceramics)
3. The iron-carbon system: microstructure development, effects of alloying elements
4. phase transformations- basic concepts, kinetics (including TTT and CCT curves), metastable vs. stable transformations including displacive (martensitic) transformations, microstructure development
5. Precipitation and dispersion hardening

XI. . Remaining Deformation (Viscoelasticity) and Strengthening Mechanisms – Chapter 8
1. Glass transition curves and crystallization of polymer and ceramic glasses
2. Deformation in glasses
3. Deformation and strengthening of polymers/Viscoelasticity

XII. Corrosion and Degradation of Materials - Chapter 16
1. Degradation of metals (electrochemical and chemical corrosion, oxidation)
2. Degradation of polymers (swelling and dissolution, bond rupture, weathering)

Contribution of the course to the professional component
This course is an introductory course in Materials Science and Engineering. It teaches the fundamentals of structure – property relationships in materials, essential in the selection of materials for specific applications, which is important in the development of all engineers.

Relationship of course to program objectives
This course serves as a foundation in Mechanical Engineering and Materials Science and Engineering. Other courses build on the basic concepts introduced in this course. It serves as a fundamental component of the curriculum because students will be called upon to conduct materials evaluations and selections in capstone design courses as well as in their post-graduate employment.

Course Procedures and Policies

Grading

Midterm I	25%	March 5th Thursday (50 min. exam)
Midterm II	25%	April 14th Tuesday (50 min. exam)
Final Exam	40%	Common Exam Schedule: May 14th (Thursday), 4 pm-6 pm
HW	10%	(expect 12-13 assignments)) including a syllabus "quiz". Homework must be submitted online and will typically be due by Weds. 11:59pm.

Grades for assignments will be posted online. For the course, plus/minus grading will be used.

Homework
Homework is intended to give students the opportunity to practice problem-solving, reflect on concepts, and apply critical thinking. Students who complete homework have improved performance on exams and understanding of course material. Not all assigned problems will be graded and problems will not be equally weighted, but detailed solutions will be available. While general concepts may and should be discussed with classmates, homework is an individual assignment. Submitted work must be your own, and by putting your name on it you are certifying that it is yours. Consultation of prior years' solutions is not permitted.
Homework will be submitted electronically. Instructions will be provided on the assignments.

It is the student's responsibility to hand in neat, readable, fully-completed homework. The teaching team is not obliged to grade messy or illegible work, and full points should not be expected for less than complete answers. Late homework will not be accepted without an excused absence. At the end of the semester, the lowest homework grade for each student will be dropped without penalty.

Citations
Non-course-related sources consulted during assignments must be cited. It is not necessary to cite the textbook or class notes. Use the following formats as guidelines.
web page example:
1. J. Alexander, DARPA, "BioFutures at DARPA", http://www.darpa.mil/focus2000/agenda/Biofutures.htm, 2000.
printed source example:
2. W. D. Callister, Jr. and D. G. Rethwisch, "Chapter 1. Introduction," Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th ed. (John Wiley and Sons, 2015), pp. 1-16.

Participation
Participation will not be graded directly, but class attendance is encouraged.

Exams
Exams will be closed-book, closed-notes. An instructor-generated equation sheet may be attached to the exam; if so, it will be posted in advance. Each exam allows each student to bring one "cheat sheet", (8.5x11") both sides, must be handwritten. The "cheat sheet" will be collected with the exam. Except calculators no other electronic devices will be permitted during exams. Midterm exams will be returned; final exams can be reviewed in Dr. Dai-Hattrick's office.

Due to the discrepancy between the time allotted per class period for each section of this course (50 min for 0101, 75 min for 0201 and 0301), all mid-term exams will be constrained to 50 minutes starting at the beginning of the regular class time.

Exams will be concept based. You should expect questions that require you to apply concepts covered in lectures and the homework. Some questions will be calculation based, some questions will require you to do calculations and then apply the answers and some questions will focus entirely on concepts.

One make-up exam will be provided per mid-term exam and final exam for students with a valid excused absence for the regular exam date. Students with prior knowledge that they will be absent (excused) on an exam date must notify the instructor by email prior to the regular exam date. Documentation need to be provided to validify the excused absence.

University Policies and Resources

Academic Accommodations
If you have a documented disability, contact Disability Support Services(0126 Shoemaker Hall). Each semester students with documented disabilities should apply to DSS for accommodation request forms, which you can provide to your professors as proof of your eligibility for accommodations. The rules for eligibility and the types of accommodations a student may request can be reviewed on the DSS web site at http://www.counseling.umd.edu/DSS/receiving_serv.html.

Academic Integrity
It your responsibility to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html

You may be asked to write the following signed statement on examinations or assignments: "I pledge on my honor that I have not given or received any unauthorized assistance on this examination (or assignment)." You may also be asked to write the names of your seat neighbors on an exam. Violations of the code of academic integrity will be referred to the Office of Student Conduct.

WileyPLUS

Introduction to Materials Engineeri

Section: Section 0301
Term: Spring 2020
Time(s): Tue 11:00am, Thu 11:00am
Instructor(s): Liyang Dai-Hattrick
Email(s): hattrick@umd.edu

Find and register for this course:

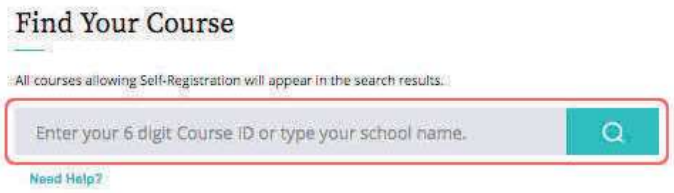
Course ID:
750589

Step 1

Find your course

·Visit **www.wileyplus.com/go/coursefinder**

·Enter your course ID, 750589



Step 2

Register and get access to the course materials

Option A

Enter Your Registration Code
All new textbooks come packaged with a registration code in a sealed envelope. E-text access is included.

Option B

Purchase Instant Access
If you don't have a registration code, you can pay for access right there on the website. E-text access is included.

Option C

Grace Period
If you're not ready to buy, you can try the course free with full access for two weeks, free. E-text access is included.

Available options may vary by location.

Need Help?

WileyPLUS Help
Live chat support: www.wileyplus.com/support