MASC 310 – Materials Behavior and Processing

Spring, 2021

Lecture

Tuesday/Thursday 10:00-11:50 a.m.

Course Description

Materials Behavior and Processing is intended for undergraduate engineering students from all engineering disciplines, as well as Iovine and Young Academy students with a technology emphasis. The subject of materials is broad, and encompasses metals, ceramics, polymers, composites, and other advanced materials. The 310 course covers fundamental concepts underlying the behavior of engineering materials, as well as materials processing methods. The course employs an integrated approach that stresses concepts that are applicable to all materials. The structure of the course primarily follows the textbook by Callister and Rethwisch, which provides a bottom up introduction to materials science incorporating fundamentals, microstructure development, properties, and manufacturing. Supplemental readings, electronic resources, and in-class labs are utilized to highlight specific concepts.

Instructor

Prof. Paulo Branicio
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Office hours: Tuesday 2 p.m. – 4 p.m. email to request an appointment on this time slot or to arrange another time

Teaching Assistant

Ms. Emily Gurniak
Email: gurniak@usc.edu
Office hours: Thursday 12:30 p.m. – 2:30 p.m. email to request an appointment on this time slot or to arrange another time

Course Objectives

Following completion of this course, students should be able to

- Explain the importance of materials science in everyday life, and in the context of engineering
- Define and differentiate between the various material families on the basis of atomic structure and bonding, properties, and processing routes
- Identify crystallographic planes and directions in cubic systems, and perform calculations based on crystal structure
- Describe relationships between the atomic structure and microstructure of a material and its properties
- Classify defects in crystalline materials on the basis of their geometry, and describe the influence of various defects on material properties and performance
- Explain if and how microstructure can be altered (via deformation, heat treatment, etc.) to modify specific material properties
- Interpret and construct phase diagrams for binary systems, and utilize time-temperature-transformation and continuous-cooling-transformation diagrams to predict microstructure

Content
A Blackboard website for the course (http://blackboard.usc.edu) will be used to access all course content. The course incorporates the use of a software package called CES EduPack. The software will be available through the Viterbi virtual desktop infrastructure (VDI). See Blackboard for installation details. An online system, WileyPLUS, will be utilized for homework assignments. WileyPLUS is integrated through Blackboard, and all readings, and assignments will be accessible through the Blackboard interface.

Text
Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th edition, William D. Callister and David G. Rethwisch, 2015, ISBN: 9781119234395. The course will utilize WileyPLUS, which comes with an online-only electronic version of the textbook. Please visit Blackboard and click on the WileyPLUS Homepage icon in the content folder to be taken through the registration process. Options are available to purchase an eBook or hard copy of the text in addition to the required WileyPLUS online access. The purchase of the WileyPLUS + eBook is highly recommended as it is the most convenient and cost-effective combination.

WileyPLUS Assignments
The online WileyPLUS system is integrated through Blackboard, and assignments and textbook readings will be accessible through Blackboard. Homework assignments are due at the start of first class of week on Tuesday. Homework is considered late if received later than the start of the class and will be penalized 50%. Homework will not be accepted after 1 week past the due date and time.

Exams
Exam scores will consist of two midterms and a final. Exams are closed book and closed notes. An equation sheet will be provided at each exam.

In-Class Labs
Materials Science is a discipline that benefits greatly from hands-on experience and practice. For this reason, several in-class labs will be completed throughout the semester to highlight concepts covered in lectures and readings. It is understood that occasionally students will need to miss class for personal reasons. Therefore, the 2 lowest in-class lab scores will be dropped when calculating the final course grade. In-class labs can be completed after class for those attending asynchronous lectures and will be accepted until the end of the day of the respective class.

Quiz
In the last module of the course students will be given a take-home quiz highlighting several topics covered in the course, to be completed individually within a week.

Grading

Grading	
WileyPLUS assignments	10%
Open book Quiz	10%
In-class labs	15%
Midterm 1	20%
Midterm 2	20%
Final exam	25%

Course Content

Topic	Text reading
Introduction to materials science and classification of materials	Ch 1
Atomic structure and bonding	Ch 2
Crystal structures and crystallographic planes and directions	Ch 3
Structure of polymers	Ch 4
Defects	Ch 5
Diffusion	Ch 6
Mechanical properties	Ch 7
Plastic deformation and strengthening mechanisms	Ch 8
Fracture and Fatigue	Ch 9
Phase diagrams	Ch 10
Phase transformations	Ch 11
Fabrication and processing of materials	Ch 14
Composites	Ch 15

Important Dates

Midterm 1: Thursday, February 18th
Midterm 2: Tuesday, March 30th
Final exam: Tuesday, May 11th 8:00 a.m.-10:00 a.m.