MSE 190 – MATERIALS SELECTION AND DESIGN

Winter Quarter 2020

Syllabus

Catalog Data. MSE 190 Materials Selection and Design (Credit Units: 4) Meaning and phases of design. Design considerations. Properties of engineering materials. Materials property charts. Materials selection. Process selection. Multi-constraint and multi-objective design. Selection of shape in mechanical components. Designing with hybrid materials: challenges and opportunities. Environmental considerations. Case studies. (Design units: 3)

Instructor: *Lorenzo Valdevit*
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Office hours: TBA

Class schedule: T Th 8.00 – 9.20pm (lecture)
TBA (discussion)

Textbook: M.F. Ashby, Materials Selection in Mechanical Design, Butterworth-Heinemann, 5th Ed., 2017 (ISBN-13: 978-0081005996)

Software: This course uses the Ansys Granta Cambridge Engineering Selector (CES) Edu Pack. Download information and video tutorials available at this address: https://grantadesign.com/education/students/video-tutorials/

References: Class notes/slides will be posted on the canvas site

Course description. This technical elective course presents a rigorous approach to materials selection in design, with emphasis on mechanical design. Using the celebrated approach pioneered by Prof. M. F. Ashby of Cambridge University – and the associated software package, students will learn how to formulate well-posed materials selection problems, clearly identifying design objectives and constraints. The same approach will be introduced for selection of shapes and processing technologies. Design of novel architected materials with superior combinations of properties will also be discussed.

Course Learning Outcomes. Students will:

1. Apply knowledge of mathematics, science, and engineering
2. Develop statistical methods to analyze and interpret data
3. Select a material to meet desired needs
4. Function on multi-disciplinary teams
5. Understand professional and ethical responsibility
6. Communicate effectively both orally and in writing

7. Understand the impact of engineering solutions in a global and societal context
8. Develop an understanding and appreciation for engineering economics
9. Develop an awareness of industry requirements for materials engineers
10. Recognize the need for life-long learning
11. Apply and integrate knowledge from each of the four primary elements of Materials Science and Engineering (structure, properties, processing and performance) to solve problems related to materials selection and design

Prerequisites by Topic: Mechanics of materials: axial, bending, shear, twisting loads on structural components; stress and strain; elastic and plastic response of materials; elastic buckling; design of structures. Introduction to materials science: classification of materials; atomic bonds; crystal structures; structural and functional response of materials; materials properties; processing/structure/properties relations.

Lecture topics:
Classification and meaning of design
Phases of design
Design considerations and constraints
Classes of materials and materials properties
Materials selection in design
Materials selection under multiple constraints and objectives
Processing of materials and process selection
Selection of shape of structural components
Designing with hybrid and architected materials
Software for materials selection
Numerous case studies

Computer Usage: Students will use the Cambridge Engineering Selector Edupack that complements the textbook. The package can be installed on individual computers and will be available in engineering computer clusters. This package will be used for homework assignments and small design projects throughout the course.

Grading Criteria:

- Homework 20%
- Quizzes/Attendance/Class participation 20%
- Midterm 30%
- Final Project 30%

Homework Policy

There will be weekly homework assignments throughout the course. Assignments will be posted on the canvas site on Friday afternoon, and are due on the same canvas site on the following Friday. Working together is strongly encouraged (but NOT copying each other). Identical homework assignments from two students will be considered cheating and not tolerated.

Most homework assignments will require the use of computational resources, in particular CES Edupack, available in the computer labs and for installation on personal computers.

These factors ALL contribute to the grade:

- Conceptually sound problem-solving approach.
- Numerical accuracy of results.
- Neatness of the presentation and description of the procedure.

Please, format your homework in a clear way. All the fundamental steps of your derivations need to be clearly stated. A correct solution obtained with a wrong or unclear methodology will be given no credit. Conversely, numerical mistakes associated with sound and reasonable approaches will result in partial credit.

Final examination

Final examination will be replaced by a final project, which counts for 30% of the grade. Expectations for the format of the project report will be communicated in class.