

MAT 424: Materials Selection for Product Design

Instructor: Dr. Ozge Akbulut,

Course meeting times: Mon: 10:40–12:30 pm, Tue: 10:40–11:30 am. There are no recitations for this class, but you are encouraged to make use of the Instructor's office hours for assistance.

Scope: The course focuses on materials selection for mechanical and everyday design of objects. It offers hands on experience in product design through a class project that includes prototyping, testing of the prototype and iterations in the product. It aims to acquaint students with a systematic materials selection procedure for product design based on properties, cost, availability, and processability of materials for product design.

Learning outcomes:

1. To establish a quantitative and qualitative understanding between design parameters and materials properties
2. To optimize performance of materials for engineering applications
3. To comprehend the importance of sustainability and environment with respect to energy consumption and recyclability of engineering components in selection of materials and fabrication process
4. To implement a framework for assessing engineering failures (please see the note for Week 8)
5. To utilize available tools (e.g., computer programs) in materials selection

Grading:

Class project (40%)

Students will be given a predetermined problem that can be solved with a tool or a device or through an improvement of an available tool or device. They are expected to present at the stages of i) idea, ii) prototype, iii) testing of the prototype, and iv) final product.

Written assignments (20%)

Term exams (40%), no final.

Required reading:

Ashby, M. F. *Materials Selection in Mechanical Design*, Fourth Edition, Butterworth-Heinemann (2010).

Suggested reading:

Charles, J. A., Crane, F. A. A. *Selection and Use of Engineering Materials*, 2nd edition, Butterworths, (1989).

Norman, D. *The Design of Everyday Things: Revised and Expanded Edition*, Basic Books (2013).

Norman, D. *Emotional Design: Why We Love (or Hate) Everyday Things*, Basic Books (2005).

Schedule

Week 1

Introduction to the concept of design-based doing

<https://uxpodcast.com/125-don-norman-part-1/>

Introduction to the class project

Product design for resource-limited settings

Week 2

Mechanical performance: stiffness, lightness etc. of beams and panels under tension and torsion, pressure vessel (common types of loading)

Performance index (materials index), Ashby Plot

Identification of design requirements

Molecular origins of density and stiffness

Individual project group meetings with the instructor, with appointment.

Week 3

Student presentations for the class project

Week 4

Thermal properties and performance

Week 5

Circular economy (Guest lecturer(s) from DCube—<https://www.d-cube.org/>)

“Made to be remade”

Week 6

Materials for additive manufacturing

<https://www.stratasys.com/materials/search>

Term Exam 1

Week 7

Manufacturing processes

Design for manufacturing

Week 8

Multiple objective optimization

Week 9

Student presentations for the class project

Week 10

Materials for biomedical applications

Design of medical devices (based on Biodesign: The process of innovating medical technologies, Paul G. Yock Stefanos Zenios Josh Makower Todd J. Brinton Uday N. Kumar F. T. Jay Watkins (Ed's). Cambridge University Press, 2015.; <http://ebiodesign.org/>)

Case studies and class discussions for biomedical design (Assignment 1, 10%)

Week 11

Startup week, guest lecturers, product design experience in selected startups

Duckt, micromobility charging solutions: <https://duckt.app/>

Spirohome: <https://tr.inofab.health/>

Week 12

Machine learning and AI in materials design and selection (Assignment 2, 10%)

Week 13

Term exam 2

Finalizing the product

Week 14

Student presentations for the class project

Related classes:

1. Economic & Environmental Issues in Materials Selection (MIT, Mat. Sci. & Eng.)
2. Emergent Materials (MIT, Architecture)
3. Materials Selection and Performance (UC Merced)