

MSE 1030: Materials Selection **Syllabus for 2024 Fall**

Instructor: Dr. Yingjie Wu (Office: SCUPI Room N405; Email: yingjie.wu@scupi.cn)

Lecture: 3 Credits, Thursday, 1:50 pm - 4:25 pm, SCUPI Room N208

Office Hours: Friday, 9:15 am – 11:55 am, SCUPI Room N405

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Prerequisites: ENGR 0022

Course Description:

This course teaches the essential methodology for materials selection in mechanical design processes, including: (i) design process and consideration, (ii) criteria for materials and their shape selection, and (iii) design case study. Mechanical components have mass; they carry loads; they conduct heat and electricity; they are exposed to wear and to corrosive environments; they are made of one or more materials; they have shape; and they must be manufactured. This course provides knowledge on how these activities are related.

Course Objectives:

The goals of this course are 1) to develop advanced understanding on the basic concepts and methodology of materials selection in mechanical design; 2) to advance better understanding on mechanical properties (i.e., fracture, fatigue, creep, deep drawability, etc.) of different materials; 3) to make materials information readily available to designers during the design process; 4) to achieve or improve on a specified product performance or eliminate a material or service failure; and 5) to solve processing difficulties and/or take advantage of new processing techniques, reduce material and/or production costs and rationalize on materials stockholding, anticipate or exploit a change in the availability of a material.

Applicable ABET Outcomes:

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
3. An ability to function on multi-disciplinary teams
4. An ability to identify, formulate, and solve engineering problems
5. An understanding of professional and ethical responsibility
6. An ability to communicate effectively
7. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Required Resources:

Textbook

1. Ashby, M. F. *Materials Selection in Mechanical Design*, 4th ed. Burlington: Elsevier, 2011. Print.

Useful supporting materials

1. Farag, M. M. *Materials and Process Selection for Engineering Design*, 3rd ed. Boca Raton: CRC Press, 2013, Print.

2. Ashby, M. F., Hugh Shercliff, and David Cebon. *Materials: Engineering, Science, Processing and Design*, 4th ed. Kidlington, Oxford, United Kingdom: Butterworth-Heinemann, 2019. Print.

3. Raman, A. *Materials Selection and Applications in Mechanical Engineering*. New York: Industrial Press, 2007. Print.

4. Dieter, G. E. *Mechanical Metallurgy*, 3rd ed. New York: McGraw-Hill, 1986. Print.

5. Meyers, M. A., and Krishan Kumar Chawla. *Mechanical Metallurgy: Principles and Applications*. Englewood Cliffs, N.J: Prentice-Hall, 1984. Print.

6. Smith, W. F. *Structure and Properties of Engineering Alloys*, 2nd ed. New York: McGraw-Hill, 1993. Print.

Course Content (tentative):

1. The Design Process

2. Initial Selection based on Mechanical Properties

2.1 Steps in Materials Selection

Mechanical properties and measurement

Fundamentals of fracture

Indices

Selection charts

Ranking

Examples

2.2 Stiffness and Strength of Composite Materials

Properties of fibers

Stiffness of composites containing uniaxially aligned fibers

Stiffness of composites containing discontinuous fibers

Fracture of composites

2.3 Materials and the Environment

Lifecycle of materials

Energy consumption over material lifetime

Eco-attributes and selection

3. Complex Issues including Material Lifetime and Reliability

3.1 Fracture and Reliability

Fracture toughness and toughening

Reliability of brittle materials

Reliability of ductile materials

3.2 Fatigue

S-N curve

Empirical relationships between fatigue lifetime and basic material properties

Fatigue of polymers

3.3 Corrosion Resistance

Definition of electrochemical corrosion

Anode and cathode reactions

Electrode Potentials and the galvanic series

Cathodic and anodic protection

High temperature oxidation

3.4 Creep and Stress Rupture

Lifetime prediction

Creep in single, two-phase systems and ceramics

Creep resistance

Grading Policies:

Requirements	Corresponding Percentages
Assignments (7)	20%
Individual Presentation	5%
Mid-Term Exam	35%
Final Exam	35%
Participation	5%

Grading Scale:

100% ≥ A ≥ 90%; 90% > A- ≥ 85%; 85% > B+ ≥ 80%; 80% > B ≥ 76%; 76% > B- ≥ 73%; 73% > C+ ≥ 70%; 70% > C ≥ 66%; 66% > C- ≥ 63%; 63% > D ≥ 60%; 60% > F.

Homework:

There will be about five homework assignments that will be submitted on Blackboard either as Word document or as pdf before the start of the class (1:50 pm) on the due day. If you are unable to attend a class, you may attach a note to your homework and submit it in advance. ***If homework is submitted late, you would lose 10% per day. You may receive no credit if homework is not submitted within a week from the due day.***

Individual Presentation:

Each student of the class needs to give a 5 min presentation that includes a 1-page handout during the semester. Handouts and slides need to be submitted to Blackboard the evening (11:59 pm) before class as a zip or rar file. Timing, presentation, style, content, and handouts will be considered for the grade. The topic can be chosen by each student (first come first serve basis) and needs to be relevant to “Materials Selection” (from research internship, coop, work, or interesting other topic) or an accident that involved failing material. If an accident is chosen as topic, 1 slide needs to be about ethical implications.

Exams:

An equation sheet might be permitted (information about this will be given a week before the exam). The students need to be present during the exam. In case of an emergency (doctors notice), a make-up exam might be given. The only allowed things during the exams are pens, ruler, water, potentially calculator. Paper and the equation sheet will be provided.

A student found *cheating, attempting to cheat*, having an *unauthorized device/tool* during the exam *independent of the reason* will receive a zero on the exam.

Participation:

Participation through presence but also answering questions, asking questions, contributing to activities is very important to improve active learning for each student. Therefore, your participation will be graded during each lecture starting with the second week.