MSE 1070: Mechanical Behavior of Materials
Syllabus for 2025 Spring

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

Lecture: 3 Credits, Wednesday, 1:50 pm - 4:25 pm, SCUPI N212
Office Hours: Friday, 1:50 pm – 4:25 pm, SCUPI N405
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Prerequisites: ENGR 0022, ENGR 0145

Course Description:

This course teaches the fundamental concepts which deals with the behavior and response of metallic materials to applied force, involving mechanical properties of metals or mechanical testing, and the field restricted to the plastic working and shaping of metals as well as more theoretical aspects of the field, which merge with metal physics and physical metallurgy. Also, the basic knowledge on applied mathematics and applied mechanics are also included in this course. This course is divided into mechanical fundamentals, metallurgical fundamentals, applications to materials testing and plastic forming of metals. Mechanical fundamentals present the basic concepts of three-dimensional stress-strain relationship, theories of yielding and plasticity. Regarding metallurgical fundamentals, the concepts of dislocation theory, strengthening mechanisms of metals and fracture mechanics are also introduced and discussed. Applications to materials testing deals with the engineering aspects of the common testing techniques of mechanical failure of metals, including tension, torsion, hardness, fatigue, creep, and impact fracture toughness tests. Additionally, the topics on plastic forming of metals dealing with the common mechanical processes for producing useful metal shapes are illustrated in this course.

Course Objectives:

In this course, students can (i) understand fundamental concepts of stress, strain and stress-strain relationships in engineering materials; (ii) apply theories of elastic and plastic deformation to analyze material response under applied loads; (iii) understand the relationship between dislocation behavior, common strengthening mechanisms, and mechanical properties of metals; (iv) analyze failure modes such as yielding, fracture and fatigue using principles of fracture mechanics; (v) perform common mechanical tests to characterize properties like tensile strength, hardness, fatigue resistance and toughness; (vi) interpret material responses from stress-strain curves obtained in tension, torsion, hardness and other tests; (vii) apply principles of applied mathematics and mechanics to analyze stresses and strains in engineering components and materials; and (viii) synthesize knowledge of mechanical and metallurgical fundamentals to solve materials selection/design problems involving metal works or plastic forming applications.

Applicable ABET Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts4. An ability to identify, formulate, and solve engineering problems
4. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Required Resources:

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

Useful supporting materials:
1. Hull, D., and D.J. Bacon. ***Introduction to Dislocations***. 5th ed., Amsterdam: Butterworth-Heinemann, 2011. Print.
2. Meyers, M.A., and K.K. Chawla. ***Mechanical Behavior of Materials***, 2nd ed., Cambridge: Cambridge University Press, 2009. Print.
3. Courtney, T.H. ***Mechanical Behavior of Materials***, 2nd ed., Long Grove, Ill: Waveland Press, 2005. Print.
4. Ashby, M.F., H. Shercliff, and D. Cebon. ***Materials: Engineering, Science, Processing and Design***, 4th ed., Kidlington, Oxford, United Kingdom: Butterworth-Heinemann, 2019. Print.
5. Raman, A. ***Materials Selection and Applications in Mechanical Engineering***. New York: Industrial Press, 2007. Print.
6. Meyers, M.A., and K.K. Chawla. ***Mechanical Metallurgy: Principles and Applications***. Englewood Cliffs, N.J: Prentice-Hall, 1984. Print.
7. Smith, W. F. ***Structure and Properties of Engineering Alloys***, 2nd ed., New York: McGraw-Hill, 1993. Print.

Course Content (tentative):

1. Elasticity
Ch 2 Stress and strain relationships for elastic behavior

2. Plasticity, Plastic deformation, and Deformation processing
Ch 3 Elements of the theory of plasticity
Ch 4 Plastic deformation of single crystals

Ch 5 Dislocation theory
Ch 6 Strengthening mechanism
Ch 8 Tension test
Ch 15 Fundamentals of metalworking
Ch 16 Forging
Ch 17 Rolling of metals
Ch 20 Sheet-metal forming

3. Fracture, Fatigue and Creep

Ch 7 Fracture
Ch 11 Fracture mechanics
Ch 14 Brittle fracture and impact testing
Ch 12 Fatigue of metals
Ch 13 Creep and stress rupture

Grading Policies:

Requirements	**Corresponding Percentages**
Assignments (8)	15%
Midterm Exam	35%
Final Exam	45%
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 eight homework assignments that will be submitted to 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.***

Exams:
If no final exam is given (based on students' approval), the exams are not cumulative. 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.