Fall 2004: Mechanical Behavior of Materials

Undergraduate: ME 378K #17760
Graduate: ME 386P-2 #17920

Instructor:
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Lectures: MWF 11:00–11:50 AM in ETC 5.132

Office Hours:
Monday: 2:00–3:00 PM
Tuesday: 2:00–3:00 PM
Wednesday: 2:00–3:00 PM

Required Textbook: Thomas H. Courtney. *Mechanical Behavior of Materials*, Second Edition. (McGraw–Hill: Boston) 2000.

Prerequisites: Undergraduates must be in the major sequence, have completed ME 311 with a grade of at least C, and either have completed or be currently enrolled in ME 111L.

Course Description: Elastic deformation; viscoelasticity; yielding, plastic flow, plastic instability, strengthening mechanisms; fracture, fatigue, creep; significance of mechanical properties tests. Applicable systems are metals and alloys, polymeric materials, and ceramics. Both microstructural mechanisms and macroscopic treatments of these phenomena are required.

Grading Policy: Grades will be based on three exams, a final exam, and a combination of quizzes and class participation, with weights given in the table below. The final exam is *optional* for undergraduate students. Approximate letter grades are given in the second table below for overall average scores.

Item	Weight
Exam I	20%
Exam II	20%
Exam III	20%
Final Exam	30%
Quizzes/Class	10%

Grade	Score
A	90 – 100
B	80 – 90
C	70 – 80
D	60 – 70
F	< 60

Important Dates: Please make note of the following important dates.

Aug. 30	—	Last day of the official add/drop period.
Sep. 10	—	Twelfth class day.
Sep. 22	—	Last day to drop a course without a possible academic penalty
Dec. 13	—	**Final Exam**, 9:00 AM–12:00 Noon in location assigned by U.T.

Library Reserve Texts: The following books are on reserve in the Engineering Library and may be of use in your studies.

1. J. F. Nye. *Physical Properties of Crystals, Their Representation by Tensors and Matrices.* (Clarendon Press: Oxford) 1957.
2. G. E. Dieter. *Mechanical Metallurgy,* 3rd ed. (McGraw-Hill: New York) 1986.
3. G. E. Dieter. *Mechanical Metallurgy,* 2nd ed. (McGraw-Hill: New York) 1976.
4. K. J. Bowman. *Mechanical Behavior of Materials.* (John Wiley: Hoboken, NJ) 2004.
5. T. H. Courtney. *Mechanical Behavior of Materials,* 2nd ed. (McGraw Hill: Boston) 2000.
6. R. W. Hertzberg. *Deformation and Fracture Mechanics of Engineering Materials,* 4th ed. (J. Wiley & Sons: New York) 1995.
7. D. Hull and D. J. Bacon. *Introduction to Dislocations,* 3rd ed. (Pergamon Press: New York) 1984.
8. J. P. Hirth and J. Lothe. *Theory of Dislocations,* 2nd ed. (Wiley: New York) 1982.
9. D. Broek. *Elementary Engineering Fracture Mechanics.* (Noordhoff: Leyden) 1974.

Homework: Homework problems will be assigned on either a weekly or biweekly basis. All students are expected to complete and thoroughly understand the homework assignments. Homework solutions will be made available on a secure web site. Homework should be collected in a notebook, corrected using the solutions provided, and turned in for grading during the last week of class.

Exams: All exams, except the final exam, will be conducted during normal lecture periods in the assigned classroom on dates specified by the instructor. The final exam will be conducted at the time and location scheduled by The University. Students are allowed to prepare one $8.5'' \times 11''$ sheet of notes, which may include both sides of the paper, for use during each exam. Each note sheet must be handed in with the exam for which it is used.

Attendance: Attendance and participation in lecture are mandatory and will be considered in grading. The instructor must be given written notice a minimum of two weeks in advance for any absences other than emergencies. If absence is required because of an emergency, such as severe personal illness or severe illness of a family member, the instructor should be notified at the earliest convenient opportunity.

Regrades: Errors in grading should be noted *in writing* and provided to the instructor with the graded item for review *no later than one week* after the item is made available to the student. *No regrades will be accepted without a written description* of the grading error, and regrades will only be conducted *in private* by the instructor.

Honesty: Any academic dishonesty will be dealt with according to University policy, including the stiffest penalty which the instructor may assess, usually a failing grade in the course. Dishonesty damages the reputation of The University and its students and will not be tolerated.

Evaluations: The course and instructor will be evaluated using standard evaluation forms at the end of the course. Students are encouraged to provide continuous feedback to the instructor throughout the course. The most effective way to do this is by visiting the instructor during office hours.

Other Items of Importance:

- The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4241 TDD, or the College of Engineering Director of Students with Disabilities at 471-4321.
- Web-based, password-protected class sites are associated with all academic courses taught at The University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1.

Course Schedule and Required Readings

Week	Topics	Chapters
8/25	Overview of Mechanical Behavior of Materials	1.1–1.2
	Basis of Elasticity	1.3–1.5
8/30	Tensor Quantities	
	Linear Elasticity and Elastic Moduli	2.1–2.4
	Special Symmetries, Isotropic and Anisotropic	2.5
9/6	*Labor Day*	
	Invariants of Deviators of Stress	Notes
	Non-linear Elasticity	2.6
9/13	Anelasticity and Viscoelasticity	2.8, 2.9
	Viscoelastic Models	2.7
	Introduction to Dislocations	3.1–3.4
9/20	Dislocation Motion	3.5–3.7
	Twinning and Dislocation Reactions	3.5, 3.7–3.8
	Dislocation Density and Stress Fields	3.8–3.10
9/27	Single-Crystal Plasticity	4.1–4.2
	Exam I	
	Crystal Rotation and Polycrystal Textures	4.3
10/4	Polycrystal Plasticity	4.4–4.5
	Geometrically Stored Dislocations, Yield Criteria	4.6–4.7, Notes
	Anisotropic Yielding and Plasticity Theory	Notes
10/11	Strengthening Mechanisms: Strain Hardening	5.1–5.3
	Boundary and Obstacle Strengthening	5.4
	Solute and Particle Strengthening	5.5–5.6
10/18	Composite Strengthening	5.7–5.9
	Creep Deformation	7.1–7.2
	Phenomenological Equation for Steady-State Creep	7.3
10/25	Deformation Mechanisms Maps	7.4
	Creep Life Predictions	7.5–7.9
	Exam II	
11/1	Elastic Deformation of Composite Materials	6.1–6.6
	Failure of Composite Materials	6.7–6.12
	Mechanisms of Fracture	9.1–9.3
11/8	Basic Fracture Mechanics	9.4
	Fracture Morphologies	9.5–9.6
	Statistical Fracture Mechanics	9.7–9.8
11/15	Toughening Mechanisms and the R-Curve	10.1–10.11
	High-Temperature Fracture	11.1–11.7
	Characteristics of Fatigue Fracture	12.1–12.3
11/22	*Exam III*	
	Design for Fatigue	12.4–12.6
	Thanksgiving Holiday	
11/29	Embrittlement	13.1–13.9
	Deformation of Noncrystalline Solids	8.1–8.7
	Case Studies, Instructor Evaluation	