MTE 455 - Mechanical Behavior of Materials
Spring 2009

Catalog Data:

MTE 455. Mechanical Behavior of Materials (3-0) Three hours. Flow and fracture of solids; uniaxial stress-strain as a reference behavior; theories of terminal stability under impact; monotonic, sustained (creep), and repeated (fatigue) loadings of solids under various states of stress.

Prerequisites:

Prerequisite: ESM 201 (Statics)

Textbook/references:

Required Text:

- G. E. Dieter, *Mechanical Metallurgy*, 3rd ed., McGraw Hill, 1986.

Reference texts:

- R.W. Hertzberg, *Deformation and Fracture Mechanics of Engineering Materials*, 4th Ed., John Wiley & Sons, 1995.
- T.H. Courtney, *Mechanical Behavior of Materials*, 2nd Ed., McGraw Hill, 2000.
- M.A. Meyers & K.K. Chawla, *Mechanical Behavior of Materials*, Prentice Hall, 1999.
- M. Vable, *Mechanics of Materials*, Oxford University Press, New York, NY, 2003. Any equivalent mechanics of materials book will suffice.
- R.E. Reed-Hill and R. Abbaschian, *Physical Metallurgy Principles*, 3rd Ed., Brooks-Cole/Thomas Learning, Boston, MA, 1992.

Course Objectives:

- Students will learn how engineering materials respond to applied mechanical loads in both a macroscopic and microscopic sense.

Topics Covered:

1. Stress and strain relations
2. Elements of elasticity and plasticity
3. Plastic deformation
4. Fracture and Fracture Mechanics
5. Fatigue
6. High temperature deformation and creep
7. Deformation of noncrystalline materials
8. Deformation of composite materials

Class schedule:

Class meets two times each week for 75 minutes per meeting. On occasion extra class periods will be necessary for laboratories and demonstrations.

Relationship of course to meeting program outcomes:

The course supports program outcomes (a), (c), (e), (f), (g), (j), (k) and (l) specified in Criterion 3 of EC 2000 which have been adopted by this program as outcomes.

Contribution of course to meeting professional component:

- Students apply knowledge of mathematics, science and engineering and formulate and solve engineering problems as they analyze the response of engineering materials to mechanical loads.
- Students develop a fundamental understanding of the response of engineering materials (metals, ceramics, polymers and composites) to mechanical loading. This includes topics on stress and strain relations, elasticity, plasticity, fracture, fatigue, and creep. These topics are introduced and discussed in lecture periods and are reinforced through homework, exams, and laboratories.
- In the laboratories, students emulate practicing metallurgical and materials engineers by working in teams, designing suitable materials testing experiments, and communicating their design processes in thorough but concise written and oral reports.
- Estimated content: Engineering Design 1 credit, Engineering Science 2 credits

Relation of course to program objectives:

The course supports program objectives 1, 2, 3, 4, 6, 7.

Prepared by: Mark L. Weaver Date: January 3, 2009

UNIVERSITY OF ALABAMA
Metallurgical and Materials Engineering Department
Spring 2009

SYLLABUS

COURSE: MTE 455 – MECHANICAL BEHAVIOR OF MATERIALS
LOCATION: TR 08:00 AM – 09:15 AM; A27 Bevill
TEXT: G. E. Dieter, **Mechanical Metallurgy** 3rd ed., McGraw Hill, 1986.
INSTRUCTOR: M.L. Weaver; Rm. A129 Bevill; 348-7073; mweaver@eng.ua.edu
OFFICE HOURS: TR 3:00 PM – 4:00 PM.

Lect.	#Date	Lecture Subjects	Reading
1	1/8	Introduction; Grading; States of Stress & Strain	Pages 1-20, 31-36, 70-76, and 275-289; Module #1
2	1/13	Ibid.	Ibid.
3	1/15	Transformation of stress in 2-D	Pages 20-27; Module #2
4	1/20	Transformation of stress in 3-D; Yield/failure criteria.	Pages 27-31, 35-38, 77-85; Module #3
5	1/22	Fundamentals of strain; Strain deviator; Mohr's circle for strain	pp. 38-46; Module #4
6	1/27	Elasticity and elastic constants	pp. 47-60; Module #5
7	1/29	Stress-strain curves; Plastic deformation; criteria for necking	pp. 275-295; Module #6
8	2/3	Theoretical strength of solids	pp. 117-119, 243-245; Module #7
9	2/5	Defects in crystals	pp. 103-114; Module #8
10	2/10	Slip by dislocation motion and dislocation theory	pp. 114-132, 145-183, 310-314; Module #9
11	**2/12**	**EXAM #I**	**EXAM #I**
	2/17	**NO CLASS – TMS, San Francisco, CA**	- - -
	2/19	**NO CLASS – TMS, San Francisco, CA**	- - -
12	2/24	Implications of dislocation motion; dislocation multiplication	pp. 119-123; Module #10
13	2/26	Slip in crystalline solids; deformation twinning and kink bands	pp. 124-144; Modules #11 and #12
14	3/3	Elastic properties of dislocations	pp. 160-168; Module #13
15	3/5	Dislocations in common crystals	pp. 154-160; Module #14
16	3/10	Dislocation mobility and stress-strain behavior	pp. 132, 197-203; Module #15
17	3/12	Introduction to strengthening and work hardening	pp. 138-143; Pages 175-179 from Courtney; Modules #16 and #17
	3/17	**NO CLASS – Spring Break**	- - -
	3/19	**NO CLASS – Spring Break**	- - -
18	3/24	Hall Petch Relationship; solid solution hardening	pp. 188-197, 203-207; Modules #18 and #19
19	3/26	Precipitation hardening; Strain gradient hardening and deformation of multiphase aggregates	pp. 185-188, 212-220; Modules #20 and #21
20	**3/31**	**EXAM #II**	**EXAM #II**
21	4/2	Fracture and Fracture mechanics	Ch. 7; Ch. 11; Ch. 14; Module #22

22	4/7	Ibid.	Ibid.
23	4/9	Creep and superplasticity	Ch. 13; Module #23
24	4/14	Ibid.	Ibid.
25	4/16	Fatigue	Ch. 12; Module #24
26	4/21	Ibid.	Ibid.
27	**4/23**	**Course Summary**	**Course Summary**
	4/28	**NO CLASS – ICMCTF, San Diego, CA**	**- - -**
	4/30	**NO CLASS – ICMCTF, San Diego, CA**	**- - -**
28	**5/4**	**FINAL EXAM**	**FINAL EXAM**

FINAL EXAM: May/4/2009 (Day/Date) 11:30AM – 2:00PM (Hour) A27 Bevill (Room/Building)

Academic and Administrative Standards

GRADING: The final grade is determined approximately as follows:

	Pts.	%
Exam 1	100	25.0
Exam 2	100	25.0
Final Exam (cumulative)	100	25.0
Assignments	100	25.0
Total	**800**	**100%**

GRADING SCALE

	A+	≥ 95%
90% ≤	A	< 95%
87% ≤	A-	< 90%
84% ≤	B+	< 87%
80% ≤	B	< 84%
77% ≤	B-	< 80%
74% ≤	C+	< 77%
70% ≤	C	< 74%
67% ≤	C-	< 70%
64% ≤	D+	< 67%
60% ≤	D	< 64%
57% ≤	D-	< 60%
57% <	F	

Note: I use a flat grading scale. A curve will not be applied under any circumstances.

MID-TERM AND FINAL EXAMINATION: Examination questions will be based upon course lectures, laboratory demonstrations, and reading material. Should a make-up examination be required, it must be made up at the next regularly scheduled departmental make-up exam period. Students are permitted to take a make-up exam if permission was obtained from the instructor prior to missing the regularly scheduled exam. ALL EXAMS WILL BE CLOSED BOOK.

HOME WORK: Assignments will be taken from the text and/or supplement lecture notes. Assignments and due dates for assignments will be given during the semester by the instructor. **They will not be accepted late without a legitimate excuse or special permission. You must obtain permission from the instructor BEFORE the due date.** Assignments will normally be returned at the next class meeting. Copying homework solutions from other student papers and turning it in as your work is dishonest and constitutes grounds for charges of academic misconduct.

CLASS PARTICIPATION: Class attendance will be recorded and students are expected to attend all classes and labs. Students are granted 3 unexcused absences. If a student will miss a class lecture, the instructor needs to be notified prior to the absence to be granted an excused absence. Class attendance is regarded as an academic matter and it is an indication of a student's maturity as well as a sign of a student's sincerity toward his/her education. Students are

responsible for all material covered in class and are expected to come to class prepared having read the assigned readings.

COURSE NOTES: Supplement course notes will be uploaded to the web site (www.bama.ua.edu/~mweaver) periodically through the semester.

POLICY ON ACADEMIC MISCONDUCT: The Code of Academic Conduct states that: "All students in attendance at The University of Alabama are expected to be honorable and to observe standards of conduct appropriate to a community of scholars. The University expects from its students a higher standard of conduct than the minimum required to avoid discipline. All acts of dishonesty in any academic work constitute academic misconduct. This includes, but is not necessarily limited to the following:

A. Cheating – using or attempting to use unauthorized materials, information, or study aids in any academic exercise.
B. Plagiarism – representing the words, ideas, or data of another as one's own in any academic exercise.
C. Fabrication – unauthorized falsification or invention of any information or citation in an academic exercise.
D. Aiding and abetting academic dishonesty – intentionally or knowingly helping or attempting to help another student commit an act of academic dishonesty.
E. Misrepresentation – falsifying, altering, or misstating the contents of documents or other materials related to academic matters, including schedules, prerequisites and transcripts.

The Code of Academic Misconduct disciplinary Procedures will be followed in the event that academic misconduct occurs. Students should refer to the Student Affairs Handbook which can be obtained from the Student Life Office in Ferguson Center.

DIASABILITY ACCESS: To request disability accommodations, please contact disability services (348-4285). After initial arrangements are made with that office, contact your instructor with the proper University forms from the disability services.

FINAL GRADE

The final grade will be determined by the student's attendance and participation in class, performance on the examinations, and assigned work. Pop quizzes can be administered in class and will be part of class participation points.

***SPECIAL NOTE*:** ASSIGNMENT SHEETS AND COURSE CONTENT ARE SUBJECT TO MODIFICATION WHEN CIRCUMSTANCES OR SOUND PEDAGOGY DICTATE AND AS THE COURSE PROGRESSES. IF CHANGES ARE MADE, YOU WILL BE GIVEN DUE NOTICE.