SAN JOSE STATE UNIVERSITY
Department of Chemical and Materials Engineering

MatE 205 Spring 2007
Advanced Mechanical Behavior of Solids W. Richard Chung

Course Syllabus

Class Hours: Tuesdays, from 1800 to 2050, Eng-301

Course Instructor: Dr. W. Richard Chung

Office Hours: Tuesdays, 2:00 - 5:00 and Wednesdays, 2:00 – 4:00 p.m.

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Textbook: Thomas H. Courtney, **Mechanical Behavior of Materials**, 2nd Edition, 2000, McGraw-Hill/Waveland Press. (ISBN0-07-028594-2/ISBN 1-57766-425-6) TA405.C859

Course Information

Course Description Selected from Catalog
Structure-property relationships in mechanical behavior of materials, including elastic, anelastic and plastic behavior; creep characteristics, fracture, testing methods, dislocation dynamics, strengthening mechanisms.

Prerequisites: MatE 115 or equivalent 3 units.

Course Website: http://www.engr.sjsu.edu/wrchung/courses.html#205

To enhance your learning, you are encouraged to periodically visit the course website for reading assignments, homework problems, solutions, and course updates. This course website site will also provide some links to other secure web sites for course learning purposes.

Course Learning Objectives
This course is designed to provide students with the in-depth knowledge related to materials deformation mechanisms, diffusion theories, strengthening techniques, mechanical testing, yielding criteria, elasticity and plasticity, fracture mechanics, stress-based fatigue and creep failure. Emphasis is placed on the relationships between structure and properties at microscopic and atomic level. The response of a material due to the presence of defects and load-bearing conditions will be discussed. Topics associated with fracture mechanics, dislocation mechanisms, and strain-based failure analysis will be integrated in the course activities.

Upon the completion of this course, you will be able to:

1. Conduct mechanical test to characterize the mechanical behavior of engineering materials including tension, compression, hardness, impact, flexure, fatigue and creep tests and interpret the collected data.

2. Measure and identify the materials properties appropriate to a specific application (e.g. mechanical, thermal, etc.)

3. Apply the basic principles of elasticity and plasticity and the importance of brittle-ductile transformation and elastic and plastic behavior of materials to industrial applications.

4. Explain and predict the behavior of a solid based on the application of external or internal forces.

5. Describe the concept of fracture mechanics and its application to product design, manufacturing method, and service reliability.

6. Perform the mathematical calculation of a multi-axial or complex stress state and relate it to the uni-axial stress state and the yielding condition.

7. Describe and predict the mechanical behavior of crystalline solids using the concepts of dislocation theory and a micro-mechanical approach.

8. Improve strengths, fracture toughness and deflect a crack's propagation through the understanding of the microstructural alignment and the associated mechanical anisotropy.

9. Explain time, temperature and other environmental factors affecting material performance in a service condition.

10. Use various yield criteria to explain material deformation mechanisms and prevent material from a catastrophic failure

11. Construct Mohr's circles to help solve and predict stress and strain distribution in a given structure

12. Analyze results of experiments using appropriate theoretical and empirical models

13. Describe material fracture behavior using spring and dash-pot models

14. Explain how notch sensitivity can affect material behavior when undergoing a mechanical loading

15. Develop and formulate equations for a problem solving related to material design and application

Useful References

S.D. Antolovich, R.O. Ritchie, and W.W. Gerberich (editors), **Mechanical Properties and Phase Transformations in Engineering Materials**, A Publication of the Metallurgical Society, Warrendale, Pennsylvania, 1986. (ISBN 0-87339-012-1) TA 401.3 M4155

Craig R. Barrett, William D. Nix, and Alan S. Tetelman, **The Principles of Engineering Materials**, Prentice-Hall, Englewood Cliffs, New Jersey, 1973. (ISBN 0-13-709394-2) TA403.B24.

David Broek, **Elementary Engineering Fracture Mechanics**, Martinus Nijhoff Publishers, Hingham, Massachusetts, 3rd Edition, 1984. (ISBN 90-247-2656-5)

George E. Dieter, **Mechanical Metallurgy**, McGraw Hill, New York, 3rd Edition, 1986. (ISBN 0-07-016853-8) TA405.D53

Norman E. Dowling, **Mechanical Behavior of Materials**, Prentice-Hall, Upper Saddle River, New Jersey, 3rd Edition, 2006. (ISBN0-13-186312-6) TA404.8D68

W.A. Green and M. Micunovic (editors), **Mechanical Behavior of Composites and Laminates**, Elsevier Applied Science Publishing, New York, 1986. (ISBN 1-85166-144-1) TA418.9C6 E976

James M. Gere and Steven P. Timoshenko, **Mechanics of Materials**, PWS-KENT Publishing, Boston, Massachusetts, 3rd Edition, 1990. (ISBN 0-534-92174-4) TA405.G44

Daniel Henkel and Alan W. Pense, **Structure and Properties of Engineering Materials**, McGraw Hill, New York, 5th Edition, 2002. (ISBN 0-07-235072-5) TA403. H397

Richard W. Hertzberg, **Deformation and Fracture Mechanics of Engineering Materials**, John Wiley & Sons, New York, 3rd Edition, 1989. (ISBN 0-471-63589-8) TA417.6H46

Donald Peckner (editor) **The Strengthening of Metals**, Reinhold Publishing, New York, 2nd Edition, 1967.

R. J. Sanford, **Principles of Fracture Mechanics**, Pearson Education, Prentice Hall, Upper Saddle River, New Jersey, 2003. (ISBN 0-13-092992-1) TA409.S26

Course Requirements

1. Preview all assigned course materials before class, and complete all homework assignments.
2. Take all written examinations and quizzes. There will be three major exams (two midterms and one final) and at least 3 pop quizzes. Examinations are comprehensive, including subjects from all assigned readings, homework problems, lectures, and classroom demonstrations. Pop quizzes usually cover the most recent readings.

   Notes: 1. At least one week's notice will be given of forthcoming exams.
   2. No make-up of examinations shall be given, except if an emergency arises. Any such situation must be documented.
3. Work and complete all assigned homework problems and term project.

Homework: Complete homework problems on one side of a sheet of paper only. You need to number all the pages if more than one page is submitted. On the upper right corner of the first page write down your name, the course number, the semester, and the submission date. List the problem numbers in the textbook and restate the statement of the problem including simple sketches, if applicable. Show your working steps and circle the numeric solutions**.** Underline them and don't forget units! The instructor will pay additional attention to these requirements. ***The homework assignments are collected according to the designated dates.*** In general, no late assignments will be accepted, as the problem solutions will be posted immediately after the class due date. Excuses for late submissions must be documented in a written format.

Note: A few points will be docked if you don't provide any formulas or working steps. It is imperative that you provide one or two sentences at the end of calculations to describe its physical meaning and your deposition. It will be a brief statement used to state the physical significance or implication of your answer.

Term Project: A term project related to mechanical testing/application/failure of a material will be assigned to class at a later time. The project is to be conducted in a **team** format. The project will involve analysis of the problem, finding root cause(s), studying material condition, and proposing a solution for the problem. Completed report will be at least 12 pages in length, double spaced not including illustrations or appendices, and will follow the class format (to be discussed in class). A writing format will also be provided at a later date.

A **group oral presentation** based on the term project report is expected to last at least 15 minutes, followed by a 5-minute discussion period. The presentation should be technical and include view graphs or visual aids related to the chosen study. The presentations should be conducted in the PowerPoint format. The instructor will reserve a portable notebook computer along with an LCD projector for presentation purpose. Transparencies, films, and/or VCR recordings (VHS) may be used in conjunction with the presentation, but may not replace spoken reporting. The presentation dates as shown in the course topic outline (next page) are scheduled in the last two weeks of the classes.

4. Participation in class is mandatory. Students who do not contribute with questions, comments, and participation in discussions can lose up to 10% of their grade (one whole letter grade). Students are expected to sit in forward seats when they are available, and to pay attention, and to ask questions when material needs to be better explained.

Grading Basis

There will be two midterms and one final exam to be administered in this course. Examinations are comprehensive; including subjects from all assigned readings, homework assignments, lectures, and classroom handouts. Homework assignments will consist of essay questions and calculation problems. **A term project must be completed and submitted by May 13th**. A class written format will be distributed at a later time.

Homework assignments and quizzes……15%
Two midterm exams (at 15% each)…..……..……..…….30%
Term project report and presentation..…….……...15%
Class interaction including class preparation, Q&A, presentations, etc…10%
Final Examination……..30%
Total: 100%

For all graded work, course letter grades will be assigned according to the corresponding ranges of cumulative averages listed below.

A+	97-100	A	94 – 96	A-	90 - 93
B+	87 – 89	B	84 – 86	B-	80 – 83
C+	77 – 79	C	76 – 74	C-	70 - 73
D	60 – 69	F	<60		

Add/Drop Policy:

Students wanting to enroll in the class must sign the roster and receive an enrollment code, provided space is available. Students may drop this class from now until February 5th without a "W" grade assigned.

Important Dates: Midterm examination dates: **March 6** and **April 17**
Final exam date: **Tuesday**, **May 22**, **1715 - 1930**

Term project report submission date: **May 15**

Academic Dishonesty

Strict University policy on academic dishonesty will be enforced in this course. Students who violate the policy will receive an F on the specific test or assignment and be reported to the University after the incident. (Refer to Academic Integrity Policy S04-12 in SJSU Catalog for Academic Dishonesty Policy.)

Cheating means getting unauthorized help on an assignment, quiz, or examination. (1) You must not receive from any other student or give to any other student any information, answers, or help during an exam. (2) You must not use unauthorized sources for answers during an exam. You must not take notes or books to the exam when such aids are forbidden, and you must not refer to any book or notes while you are taking the exam unless the instructor indicates it is an "open book" exam. (3) You must not obtain exam questions illegally before an exam or tamper with an exam after it has been corrected.

Plagiarism means submitting work as your own that is someone else's. For example, copying material from a book or other source without acknowledging that the words or ideas are someone else's and not your own is plagiarism. If you copy an author's words exactly, treat the passage as a direct quotation and supply the appropriate citation. If you use someone else's ideas, even if you paraphrase the wording, appropriate credit should be given. You have committed plagiarism if you purchase a term paper or submit a paper as your own that you did not write.

For more information on the SJSU student code of conduct:
http://sa.sjsu.edu/judicial_affairs/students/index.html

Mat E 205 Course Activity Outline

Textbook: Thomas H. Courtney, **Mechanical Behavior of Materials**, Waveland Press, Inc., 2nd Edition, 2000. (ISBN 1-5766-425-6)

Week	Starting Date	Reading: Chapter #	Homework Assignments	Important Events
1	Jan. 30	Ch.1 Overview of Mechanical Behavior	1.1, 1.4, 1.6, 1.12	
2	Feb. 6	Ch. 2 Elastic Behavior	2.1, 2.10, 2.14, 2.20	HW1
3	Feb. 13	Ch. 3 Dislocations	3.3, 3.5, 3.12, 3.15	
4	Feb. 20	Ch.4 Plastic Deformation of Single Crystals and Polycrystalline Materials	4.2, 4.3, 4.8, 4.13	HW2
5	Feb. 27	Ch.5 Strengthening Mechanisms	5.2, 5.10, 5.12, 5.24	
6	**Mar. 6**	Ch.6 Composite Materials	6.4, 6.6, 6.11, 6.13	**Exam 1 – Mar. 6**
7	Mar. 13	Ch. 7 High Temperature Deformation of Crystalline Materials	7.6, 7.7,7.14, 7.20	HW3
8	Mar. 20	Ch. 8 Deformation of Non crystalline Materials	8.6, 8.7, 8.17, 8.21	
	Mar. 26 – Mar 30	**Spring Break – No Classes!**		
9	Apr. 3	Ch. 9 Fracture Mechanics	9.3, 9.7, 9.10, 9.16	HW4
10	Apr. 10	Ch. 10 Toughening Mechanisms	10.4, 10.6, 10.15, 10.28	
11	**Apr. 17**	Ch. 11 High Temperature Fracture	11.4, 11.5,11.16, 11.18	**Exam 2 – Apr. 17**
12	Apr. 24	Creep Deformation of Materials		HW5
13	May 1	Ch. 12 Fatigue of Engineering Materials	12.5, 12.7, 12.10, 12.22	**Oral Presentation (I)**
14	May 8	Fatigue Crack Growth		**Oral Presentation (II)**
15	May 15	Course review	Last Day of Instruction	**Report Due**
16	**May 22**	**Final Examination**	**1715-1930**	