Civil and Environmental Engineering
CE 525 Mechanical Damage of Materials

Instructor:	Dr. Yongming Liu 234 Rowley Laboratories; Tel: 268-2341 E-mail: yliu@clarkson.edu Web: people.clarkson.edu/~yliu
Office Hours:	**TuTh 10:00 -11:00**; and anytime when I am in the office with the door open
Lecture/Lab:	**TuTh 8:00– 9:15 CAMP 184**
Web access:	Active Directory: S:\Classes\CEE\CE525

Catalog Description: Elastic and plastic deformation of materials, fundamentals of fracture mechanics, fatigue mechanisms and material micro-structural behavior, fatigue crack initiation and propagation analysis of metallic and composite materials, damage accumulation under multi-axial load, creep and other types of mechanical damage, probabilistic damage growth analysis and reliability, application to structural life prediction and design.

Prerequisites: ES 222

Textbook: *Mechanical behavior of materials:* Engineering Methods for Deformation, Fracture, and Fatigue, Third Edition, Norman Dowling, Prentice-Hall, Inc. (recommended)
ISBN 0-13-186312-6

Software: Matlab, ANSYS (recommended)

Course Objectives:

1. To examine and comprehend the principles involved engineering analysis of mechanical damage of materials.
2. To enable students to use fundamental principles of mechanics for the development and applications of material/structural damage prognosis.
3. To train students of scientific computation, engineering statistics, data analysis, and academic writing.
4. To introduce of advanced and currently active research topics in the damage, fracture, and fatigue communities.

Topics Covered:

Topic	Hours
Introduction of mechanical damage of materials	2 hours
Review of mechanics of materials	2 hours
Elastic and plastic deformation of materials	4 hours
Fundamentals of fracture mechanics	6 hours
Fatigue crack initiation of materials	8 hours

Fatigue crack propagation of materials	8 hours
Advanced topics	6 hours
Exams	2 hours

Class Schedule:

Two 75-minute lectures per week

Contribution to Professional Component:

3 credits of Civil Engineering

Examination policy:

The in-class exam will be given in the CAMP 184 on Thursday November 3 at 7:30 am. There will be no make-up exam. In unusual circumstances excuses may be granted for the in-class exams. For predictable absences excuses must be requested well in advance of the exam day. Excused exam will increase the weight of the term paper. There will be **no Final Exam**. Exams will be open book and open notes. The original problem papers and your solutions will be stapled together and turned in.

One project, **one term paper**, and an **oral presentation** will be required. Each student will finish the assignment and submit an individual report. Detailed requirements and formatting will be given separately during the semester.

Evaluation Methods:

1. Exam I (Nov. 4)	20	20%
2. Project	20	20%
2. Term paper	25	25%
3. Homework	20	20%
4. Oral Presentation	15	15%

100 total points

Letter grades will be assigned based on the following scale:

A	for	$G > 90$,
B+	for	$85 < G \leq 90$,
B	for	$80 < G \leq 85$,
C+	for	$75 < G \leq 80$,
C	for	$70 < G \leq 75$,
D+	for	$65 < G \leq 70$,
D	for	$60 < G \leq 65$,
F	for	$G \leq 60$.

The above represent minimum bounds. I reserve the right to adjust the grading scale to your benefit, based on your class performance.

CE 525 – Mechanical Damage of Materials

Introduction
Survey of Engineering Materials
Types of Material Damage and Failure
Mechanical Design and Material Selection
Experimental and Numerical damage analysis

Review of Mechanics of Materials
Analysis of stress and strain
Stress-Strain relationships
Complex stress state
Yielding and Strength of Materials
Elastic stress concentration for notches

Plastic deformation
Monotonic Stress-Strain Curves
Cyclic Stress-Strain Curves
Time-dependent deformation behavior
Plastic deformation of materials and components
Plasticity of Notched members

Fundamentals of fracture mechanics
Preliminary discussion and mathematical concepts
Stress Intensity Factor
Plastic modification of LEFM
Extension of fracture mechanics beyond linear elasticity

Fatigue of materials
Stress-based approach to fatigue
Strain-based approach to fatigue
Crack growth-based approach to fatigue
Multi-axial fatigue analysis
Application to components and structures
Probabilistic fatigue damage analysis

Advanced topics
Creep and other types of mechanical damage
Fatigue of composite materials
Corrosion and fatigue

Persons(s) who prepared this description and date of preparation:

Y. Liu Aug 29, 2011