Department of Mechanical Engineering
ME EN 7530 · Fracture and Fatigue · Spring 2015

Syllabus

Instructor:	Prof. A. Spear, KENN 2151, email correspondence via course website
Office hours:	M,W: 4:30pm-5:30pm (or by appointment), KENN 2151
Units:	3
Meeting times:	M,W: 3:00pm-4:20pm, MEB 2325
Required text:	*Fracture Mechanics: An Introduction (Solid Mechanics and Its Applications)*, E.E. Gdoutos (2nd Ed.). ISBN-13: 978-1402028632. Additional reading material will be provided via the course website.
Supplementary text:	*Fracture Mechanics*, T.L. Anderson (3rd Ed.) *Fatigue of Materials*, S. Suresh (2nd Ed.)
Course website:	Hosted on CANVAS
Pre/Co-requisites:	ME EN 6300 OR ME EN 6500 OR instructor consent

Course summary:
Theory and application of fracture mechanics to design against catastrophic failures in structures. Mechanisms of fracture, stress-intensity factors, elastic and elasto-plastic design criteria, fracture toughness, crack propagation, and fatigue; fracture-control plans.

Course objectives:
The overarching goal of this course is to expose students to the mechanisms of fatigue and fracture, by which many structures and materials fail. By the end of this course, students will:

1) Have a fundamental understanding of linear elastic fracture mechanics (LEFM) and the conditions under which LEFM is valid;
2) Have a fundamental understanding of generalized (nonlinear) fracture mechanics;
3) Have a fundamental understanding of various regimes of fatigue crack growth;
4) Have a working understanding of different analytical, numerical, and experimental methods to assess the integrity and/or life of structural components.

Course topics:

1) Introduction to and brief history of fracture mechanics
2) Linear elastic fracture mechanics
3) Generalized (nonlinear) fracture mechanics
4) Fatigue
5) Special topics in fatigue and fracture mechanics

Deliverables and grading:

Assignments	50%
Midterm exam	20%
Final exam	30%

The total score is the weighted average of the assignments, midterm exam, and final exam, as described in the table above. A curve (upward) will be applied only if the scores on exams or assignments are lower than expected. Otherwise, no curve will be applied. It is anticipated that the mean total score will result in a B+ letter grade.

Exams:
Midterm exam: Wed., March 4 (in class)
Final exam: Thurs., April 30 (1:00pm-3:00pm, location TBD)
Exams cannot be taken at different times/dates, except as documented in accordance with university policy.
Exams are closed-book. Content for each exam will be specified in a timely manner.

Assignment guidelines:
This is a graduate-level course; therefore, it is expected that assignments will be presented in a professional manner. Specifically, the assignments should:

1) *Clearly* define and articulate the problem statement using words and figures.
2) *Clearly* describe the solution method or approach, including explicit mention of any assumptions that are made.
3) *Clearly* state the final solution, including units (if applicable) and a statement about the reasonableness and possible implications of the findings.

Some problems will be assigned directly from the course textbook; while others will be more open-ended and require creativity and critical thinking. Specific instructions will be provided for each assignment.

Conduct and responsibilities:
All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.

Classroom etiquette:
Attendance *and* participation are expected in this graduate-level course. While skeleton notes of the lectures may be provided online, detailed lecture notes will not be provided by the professor. Thus, if you miss class, it is your responsibility to obtain the lecture information from another student.

The following guidelines are for Fall 2014 and will be updated when the Spring 2015 guidelines become available.

COLLEGE OF ENGINEERING GUIDELINES

http://www.coe.utah.edu/wp-content/uploads/pdf/faculty/semester_guidelines.pdf **Fall Semester 2014**

Appeals Procedures

See the Code of Student Rights and Responsibilities, located in the Class Schedule or on the UofU Web site for more details

Appeals of Grades and other Academic Actions

If a student believes that an academic action is arbitrary or capricious he/she should discuss the action with the involved faculty member and attempt to resolve. If unable to resolve, the student may appeal the action in accordance with the following procedure:

1. Appeal to Department Chair (in writing) within 40 business days; chair must notify student of a decision within 15 days. If faculty member or student disagrees with decision, then,
2. Appeal to Academic Appeals Committee (see http://www.coe.utah.edu/current-undergrad/appeal.php for members of committee). See II Section D, Code of Student Rights and Responsibilities for details on Academic Appeals Committee hearings.

Americans with Disabilities Act (ADA)

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you need accommodations in a class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, 162 Olpin Union, 581-5020 (V/TDD) to make arrangements for accommodations. All written information in a course can be made available in alternative format with prior notification to the Center for Disability Services.

Repeating Courses

When a College of Engineering class is taken more than once, only the grade for the second attempt is counted. Grades of **W, I, or V** on the student's record count as having taken the class. Some departments enforce these guidelines for other courses as well (e.g., calculus, physics). See an advisor or departmental handbook. Students should note that anyone who takes a required class twice and does not have a satisfactory grade the second time may not be able to graduate.

Withdrawal Procedures

See the Class Schedule or web for more details ** Please note the difference between the terms "drop" and "withdraw". Drop implies that the student will not be held financially responsible and a "W" will not be listed on the transcript. Withdraw means that a "W" will appear on the student's transcript and tuition will be charged. **

Drop Period – No Penalty

Students may DROP any class without penalty or permission during the FIRST TEN calendar days of the term (Wednesday, September 3, 2014).

Withdrawal from Full Term Length Classes

Students may WITHDRAW from classes without professor's permission until **Friday, October 24, 2014**. From September 4-8 a "W" will appear on the transcript but NO tuition will be charged. Between September 9 and October 24, a "W" will appear on the transcript AND tuition will be charged. Refer to Class Schedule, Tuition and Fees for tuition information.

Withdrawal from Session I & Session II

See the web page for details:
http://registrar.utah.edu/academic-calendars/fall2013.php

Withdrawals **after October** 24 will only be granted due to **compelling, nonacademic emergencies**. A petition and supporting documentation must be submitted to the Dean's Office, 1602 Warnock Engineering Building or University College (450 SSB) if you are a pre-major. Petitions must be received before the last day of classes (before finals week).

Adding Classes

Please read carefully: All classes must be added within two weeks of the beginning of the semester (deadline: Monday, September 8). Late adds will be allowed September 9-15, requiring only the instructor's signature. Any request to add a class after September 15th will require signatures from the instructor, department, and Dean, and need to be accompanied by a petition letter to the Dean's office.

A $50 FEE WILL BE ASSESSED BY THE REGISTRAR'S OFFICE FOR ADDING CLASSES AFTER September 15th. ***

Lecture	Date	Topic	Description	Reading†	
1	M: Jan. 12	Introduction	Administrative items; introduction to/history of fracture mechanics	1.1-1.4	Linear Elastic Fracture Mechanics
2	W: Jan. 14	Crack-driving forces: energy approach	Energy balance and energy release rate (G)	4.1-4.4	
	M: Jan. 19	MLK Jr. Day (no class)			
3	W: Jan. 21	Crack-driving forces: stress approach	Stress fields and stress intensity factors (K)	2.1-2.5	
4	M: Jan. 26	Crack-driving forces: stress approach	Stress fields and stress intensity factors (K)		
5	W: Jan. 28	Crack-driving forces	Methods for determing K and G (analytical, experimental)		
6	M: Feb. 2	Crack-driving forces	Methods for determing K and G (numerical)		
7	W: Feb. 4	Crack-driving forces	Methods for determing K and G (numerical)		
8	M: Feb. 9	Crack-resisting forces	Fracture toughness, toughness testing, R-curve	5.3-5.5	
9	W: Feb. 11	Predicting crack growth	Fracture criteria: crack growth, crack path (mixed-mode)	5.6, 7.1-7.4	
	M: Feb. 16	Presidents' Day (no class)			
10	W: Feb. 18	Predicting crack growth	Fracture criteria: crack growth, crack path (mixed-mode)	7.5-7.7	
11	M: Feb. 23	Introduction to nonlinear fracture mechanics	Competition between plasticity and fracture; elastic-plastic stress fields	3.1-3.4	Generalized (Nonlinear) Fracture Mechanics
12	W: Feb. 25	Generalized (nonlinear) fracture parameters	J-integral	6.1-6.6	
13	M: Mar. 2	Generalized (nonlinear) fracture parameters	Crack-tip opening displacement	6.8	
	W: Mar. 4	MIDTERM (Topics in Linear Elastic Fracture Mechanics)			
14	M: Mar. 9	Generalized (nonlinear) fracture parameters	Traction laws and cohesive zone models		
15	W: Mar. 11	Predicting generalized crack growth	Predicting elasto-plastic crack growth and residual strength		
	M: Mar. 16	Spring Break (no class)			
	W: Mar. 18	Spring Break (no class)			
16	M: Mar. 23	Introduction to fatigue	Introduction to fatigue and fatigue design philosophies	9.1	Fatigue
17	W: Mar. 25	Total-life approaches	Stress-life approach, strain-life approach		
18	M: Mar. 30	Damage-tolerant approach	Simple fatigue-crack propagation models in regimes I/II/III	9.2-9.3	
19	W: Apr. 1	Fatigue testing and analysis	Constant amplitude, K-control, spectrum loading		
20	M: Apr. 6	Residual stresses	Effects and analysis of residual stresses		
21	W: Apr. 8	Guest lecturer from Hill AFB	Damage tolerance, current lifing techniques		
22	M: Apr. 13	Materials science perspective on fatigue	Material deformation, micromechanics of crack nucleation, Stage I/II	10.1-10.6	
23	W: Apr. 15	Corrosion	Environmentally assisted cracking, effect of corrosion pitting		Special Topics in Fracture
24	M: Apr. 20	Fractography	Post-mortem characterization of failure surfaces		
25	W: Apr. 22	Guest lecturer from Composites Lab	Fracture and delamination in composite materials		
26	M: Apr. 27	Course content review and debriefing			
	Th.: Apr. 30	FINAL EXAM (1:00-3:00pm)			

† Assigned reading from Gdoutos due on the date indicated. Additional reading from non-required textbooks and journal articles will be made available on CANVAS.