

Schedule: MWF 11:00am-11:50am in 2078 Natural History Building

Course websites:

- Class schedule, announcements, (pre)lecture videos, lecture notes, worksheets, gradebook, and homework deposit:
canvas.illinois.edu
- Class announcements and online discussion forums:
campuswire.com

Scope: This course provides an advanced treatment of mechanical behavior of materials, drawing from solid mechanics, defects theory, thermodynamic and kinetic principles. Fundamentals of elastic and plastic deformation are reviewed to provide a basis for more advanced topics including creep, fracture and fatigue. These deformation mechanisms are connected with underlying microstructural features, loading conditions and service conditions in the context of engineering design.

Objectives: Students will be able to explain macroscopic mechanical behavior of materials in the context of microscopic mechanisms and apply this understanding to calculate mechanical behavior of known and developing engineering systems. Students will be able to evaluate mechanical failure modes to identify causes and solutions and will be able to design experiments that evaluate specific failure mechanisms.

Prerequisites: MSE 406 (Mechanical Behavior of Materials)

Instructor: Jessica Krogstad (jakrogst@illinois.edu; 206 MRL)

Office hours: Tu 1:30pm-2:30pm, Th 3:00pm-4:00pm or by appointment; Office hours will be held in MRL206; Hours/location may be adjusted as needed.

Reference Texts:

Mechanical Behavior of Materials, Thomas H. Courtney, 2nd ed. (Waveland Press, 2013); *Statics & Mechanical Behavior of Materials*, Marc Meyer & Krishan Chawla, 3rd ed. (Cambridge, 2009); *Deformation and Fracture Mechanics of Engineering Materials*, Richard W. Hertzberg, 4th ed. (John Wiley & Sons, 1996); *Mechanical Metallurgy*, George Dieter, SI Metric ed., (McGraw-Hill, 1988); *Engineering Materials 1*, Michael Ashby and David Jones, 3rd ed. (Butterworth-Heinemann, 2005); *Mechanical Behavior of Materials*, Williams F. Hosford, 1st ed. (Cambridge, 2005); *Fracture Mechanics*, Ted L. Anderson, 3rd ed. (CRC Press, 2005); *Fatigue of Materials*, S. Suresh, 2nd ed. (Cambridge University Press, 1998); Available at Engineering Reserves in Grainger.

Course structure and expectations: This course is structured to emphasize student-centered learning. Instructor-centered lecturing will be limited to short 5-10 minute segments. This allows students to develop a greater depth of understanding during class time through exploration of the course material in guided worksheets. Working in small groups of 3-4, students will discover material that would have otherwise been imparted through lecture (these are not just practice problems) and in doing so, will acquire problem solving skills and establish key connections between higher level concepts. Regular attendance and active participation during class are critical for success in this class. The in-class worksheets are supported by written lecture notes and suggested readings. Frequent low-risk assessments, including weekly homework assignments and biweekly quizzes, will provide opportunity for regular practice and revision of concepts initially explored during in-class discussions.

Special accommodations: To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact their lecturer and the Disability Resources and Educational Services (DRES, disability.illinois.edu) as soon as possible, and no later than Sept. 4.

Course evaluation:

$$12\% \times (\text{Participation}) + 13\% \times (\text{Homework}) + 15\% \times (\text{Final Project}) + 35\% \times (\text{Quizzes}) + 25\% \times (\text{Final Exam}) = \text{Total}$$

Participation (12%): Participation will be quantitatively measured by completion of a daily *worksheet* (and/or attendance) during the lecture period with the help of a small group. Worksheets will be available 24 hours in advance of each lecture period. Hard copies will be available at the beginning of each class, but students are also welcome to work on personal tablets, etc. Completed worksheets must be turned in at the end of each lecture or be uploaded to CANVAS no later than 7:00PM on the day it is due (usually the day you worked on it). These *worksheets* will not be graded for accuracy and will be returned at the beginning of the next class period. Solutions to the worksheets will be posted to CANVAS.

Attendance is mandatory, but for the health and safety of all students please do not attend class if you're feeling unwell. Students may miss up to four lectures *for any reason* before the participation grade is impacted; after that 1% will be deducted from the participation grade for each one missed. For anticipated absences, see below.

Homework (13%): Homework is assigned and collected weekly on Wednesdays at the beginning of class (11AM) and returned by the following Wednesday. No late homework will be accepted, but the two lowest homework scores will be dropped. Completed homework assignments must be submitted through the CANVAS website. Feedback on the homework will be very light touch. Solutions will be posted at 12PM on the due date unless stated otherwise.

Final Project (15%): Over the course of the semester, students will explore a materials application with relevance to the course material as determined by the instructor in *teams of two*, selected by the students. This will culminate in a final poster presentation held during the class period on Friday, December 4 or Monday, December 7. The final project must

- demonstrate familiarity with the common failure modes of the system,
- identify how concepts discussed in class are related or are synergistic
- identify where the field is going and novel techniques or models that may change the conventional teaching in MSE440 in the future and
- include an experiment or model designed by the student that could evaluate one of the outstanding challenges for the materials system, including detailed description of how the experiment or model was inspired by the literature or working with other students.

There will be 4 major milestones over the course of the semester:

1. Project planning meeting #1: During a 20 minute discussion with Prof. Krogstad you must demonstrate basic familiarity with your chosen system and the failure modes. You must have identified at least 3 reliable literature sources prior to your one-on-one discussion.
2. Milestone #2: A two-page report discussing an overall perspective of the field (based on the previously identified sources), predominant failure mechanisms, connections to class and an outlook on the direction of the field. This report will be graded for accuracy, clarity and originality. See the course AI policy below for more details.
3. Project update meeting #3: During a 20 minute discussion with Prof. Krogstad you must be prepared to discuss a possible experiment or modeling approach designed to address a specific challenge in the materials system.
4. Final Poster Presentation: A digital copy of the poster must be submitted via CANVAS. In addition to specifically addressing the 4 points outline above, the poster will also be evaluated on

the basis of clarity & presentation style.

Quizzes (35%): Quizzes will be conducted in two formats, either in class, written exams or one-on-one discussions with the instructor, approximately 10 minutes in length. Quizzes will take place on a biweekly basis. Written exams will be held during the lecture period and will last 25 minutes, while oral quizzes will occur outside of the class period. For oral quizzes, students will have an opportunity to sign up for a time slot that best fits in their schedule. Sign up will be on a first come-first serve basis and will be available at least one week in advance of the quiz. In the case of illness or other emergency, quizzes may be rescheduled at the instructors discretion. See the excused absences section below for more details.

Each quiz will center around a predefined scenario or case study that will be provided at least one week in advance. This scenario will also include targeted study topics and relevant formulas. Students will be asked a short series of questions related to the scenario. This type of exam structure leverages your knowledge of the targeted scientific fundamentals with problem solving. You are welcome to have notes available but the time will be very short and you may not have sufficient time to reference your notes extensively.

If you've never taken an oral exam, it might make you a little bit nervous. There are a few things you can do to prepare for this type of exam (these are also great study tips for written exams).

- The questions will be very similar to the flow of the in-class worksheets. Reviewing worksheets is a good place to start studying. Are there points that you didn't understand?
- Study with a partner so you can practice talking through problems.
- Practice connecting the study topics through logical arguments.
- Practice!

Each quiz will be worth 10 points. Oral quizzes will include immediate feedback following the quiz, while written quizzes will be returned within one week. The lowest quiz score will not be included in the final grade calculation.

Final Exam (25%): A comprehensive written final exam will be held on Wednesday, December 16 between 8:00-11:00 AM.

Grade Reporting: All assessment scores are stored on the CANVAS website. Any errors in grade reporting appearing on CANVAS must be reported within 2 weeks of the due date of the assessment item or by the last day of class, whichever is earlier.

Expectations: To succeed in this class, you will need to

- view the prelecture video or review the lecture notes *before* coming to class, and formulate questions;
- participate in the in-class discussions;
- make sure you understand the worksheet and homework problems and solutions;
- seek out help when you have trouble.

Obtaining help: The main two ways to obtain help are online at Campuswire or during office hours. You can also speak with your professor briefly after lecture. Please do not send email directly to the professor for routine help or absences. In cases of emergencies related to exams (e.g., illness) you should email your professor at the earliest possible opportunity.

Online Forum (Campuswire): This class uses Campuswire for all communication between the instructor and students. Please visit campuswire.com to register with your @illinois.edu email address. You may need the *Join Class Code: 7125* the first time. If you desire, you can post anonymously on Campuswire or make a private post just to the instructors (this should be done

rather than emailing the professor directly). You can also use the chat rooms feature on Campuswire study groups etc. *Note that Campuswire should be used to communicate with your instructors, rather than email.*

Use of Generative AI: Generative AI tools can be very helpful to the learning process; however, they can also introduce some challenges so they must be used thoughtfully. This means leveraging AI use in ways that enhance your learning experience, e.g. providing additional clarification on a concept or helping to generate study questions. For more guidance on how AI tools can be synergistic with the learning and research processes, please refer to the library [Generative AI Guide](#). In this course, the use of AI tools is not disallowed, but use must be disclosed and described in all instances. For example, if you use AI to help with code generation, brainstorming, searching, or editing, etc., you must include a disclaimer on your submitted assignment about these uses with details about which sections were impacted and in which way.

Absences: Excused Absence Request Form: illinois.edu/fb/sec/4107592

1. Regular attendance is very important for your progress and success in this course. Excuses from assessments will be considered in the following circumstances:
 - (a) Illness.
 - (b) Personal crisis (e.g., car accident, required court appearance, death of a close relative).
 - (c) Religious observance.
 - (d) Required attendance at an official UIUC activity (e.g., varsity athletics, band concert).
2. In all cases you must complete the online Excused Absence Request Form and upload a scan of the official written documentation explaining your absence. This form helps to organize all request to ensure that nothing is overlooked or lost via email or more informal communications.
3. In cases (a) or (b) please provide some form of documentation via the online form within 2 weeks of the due date of the missed assessment, but no later than reading day (December 9). In cases of extended or unusual illness, late submission of excuse documentation will be considered. See [Student Assistance Center](#).
4. In case (c) please notify the instructor by completing an Excused Absence Request form at least one week prior to the due date of the missed assessment.
5. In case (d) an official letter from the designated university official must be submitted via the online form at least one week prior to the due date of the missed assessment.
6. If you will not be able to take a quiz due to illness or any other reason, you must send email to your professor at the earliest possible opportunity. Quizzes may be rescheduled at the discretion of the instructor but may involve a new scenario.
7. Notwithstanding the above, at the professor's discretion you may be required to make up any excused work or attend substitute instruction or assessment.

Academic Integrity, Harassment, and Discrimination: You are bound by the [University Honor Code](#) in this course. Any violation of the Honor Code will result in disciplinary action. In addition, harassment or discrimination of any kind will not be tolerated. Please report any concerns immediately to your professor.

Community of Care: As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the [Student Assistance Center](#) (217-333-0050). Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe.

Further, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at the [Counseling Center](#) or [McKinley Health Center](#). For mental health emergencies, you can call 911 or walk in to the Counseling Center, no appointment needed.

Changes to syllabus: may occur as deemed necessary by the professor; they will be announced.

Calendar and Topics: Changes to schedule will be announced; see CANVAS calendar for specific reading assignment and to remain up to date.

	Assignments Due			Content	<i>Description</i>
	Quiz	Worksheets	Homework	Lesson	
M Aug 24				0	Intro to student-centered learning
W Aug 26		1.1	HW0	1	Elasticity
F Aug 28		1.2			
M Aug 31					<i>no class</i> Labor Day
W Sept 02		2.1	HW1	2	Dislocations
F Sept 04		2.2			
M Sept 07		2.3			
W Sept 09		3.1	HW2	3	Plasticity - Single Crystals
F Sept 11	1				Quiz 1 - Elasticity
M Sept 14		3.2			
W Sept 16		4.1	HW3	4	Plasticity - Polycrystals
F Sept 18		4.2			
M Sept 21		5.1		5	Strengthening
W Sept 23		5.2	HW4		
F Sept 25	2				Quiz 2 - Dislocations & Plasticity
M Sept 28		5.3			
W Sept 30			HW5	6	Engineering Failure
F Oct 02		7.1	FP1	7	Project planning meeting
M Oct 05		7.2			Creep
W Oct 07		7.3	HW6		
F Oct 09	3				Quiz 3 - Plasticity & Strengthening
M Oct 12					
W Oct 14			HW7	8	Fracture
F Oct 16					
M Oct 19					
W Oct 21			HW8		
F Oct 23	4				Quiz 4 - Creep
M Oct 26				9	Fracture - Toughening
W Oct 28			HW9		
F Oct 30			FP2	10	Fracture - Cleavage
M Nov 02					
W Nov 04			HW10	11	Fracture - Ductile
F Nov 06	5				Quiz - LEFM & Brittle Fracture
M Nov 09					
W Nov 11			HW11		
F Nov 13			FP3	12	Fatigue, Project update meeting
M Nov 16					
W Nov 18			HW12		
F Nov 20	6				Quiz - Cleavage & Ductile Fracture
— fall break —					
M Nov 30				13	Fatigue - Mechanisms
W Dec 02			HW13		
F Dec 04			FP4		Project Final Project Presentations
M Dec 07					
W Dec 09	7		HW14		Quiz - Fatigue
Th Dec 10		—		—	Reading Day
W Dec 16	F				8:00-11:00am, Final Exam