Schedule: MWF 11:00am-11:50am in 2101 Everitt Laboratory

Course websites:

- Class schedule, announcements, prelecture videos, lecture notes, worksheets, gradebook, and homework deposit:
  canvas.illinois.edu
- Class announcements, live chat during lecture 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; 168 MRL)
Office hours: M 3:00pm-4:00pm, Th 3:00-4:00 or by appointment; Office hours will be held on the patio of the Materials Research Laboratory for as long as weather permits; 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, 2nd 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.

Online course structure and expectations:: This course is structured to emphasize student-centered learning. We call it *flipped learning*. Instructor-centered lecturing will be limited to short 5-10 minute prelecture videos. 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. 3.

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* 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 turned in at the end of each lecture or be uploaded to Canvasno 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 not be posted separately, but can be revisited and discussed during office hours.

Attendance is mandatory, but for the health and safety of all students please do not attend class if you're feeling unwell or experiencing any symptoms frequently attributed to COVID-19. 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. A physical copy of homework assignments may be turned in at the beginning of lecture or may 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.

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 presentation held during the class period on either Monday, December 6 or Wednesday, December 8. 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. Project update meeting #2: During a 30 minute discussion with Prof. Krogstad you must be prepared to discuss an overall perspective of the field (based on the previously identified sources), connections to class and an outlook on the direction of the field.
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 presentation must be submitted via Canvas. In addition to specifically addressing the 4 points outline above, the poster will also evaluated on the basis of clarity & presentation style.

Quizzes (35%): Quizzes will be conducted through small group (teams of two, selected by the students) discussions with the instructor, approximately 15 minutes in length on a biweekly basis. During weeks with quizzes there will be no lecture session on Friday. Instead student teams (quiz buddies) will have an opportunity to sign up for a time slot, that may encompass the lecture period, 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.

Perhaps you've never taken an exam like this. Perhaps it makes you a little bit nervous. There are a few things you can do to prepare for this type of exam.

- The questions and flow of the oral examination 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, especially your quiz buddy, so you can practice talking through problems.
- Practice connecting the study topics through logical arguments.
- Practice!

Each quiz will be worth 10 points and you will be provided will immediate feedback following the quiz. Only the 5 best quiz scores will be included in your final grade calculation.

Final Exam (25%): A comprehensive written final exam will be held on Friday, December 10 between 1:30-4:30 PM.

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 *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. Campuswire is a FERPA compliant replacement for Piazza. Please visit campuswire.com to register with your @illinois.edu email address. You may need the *Join Class Code: 7664* 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.*

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

1. I understand that this fall is a little different than usual, but 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	
	Quiz	*Worksheets*	*Homework*	*Lesson*	*Description*
M Aug 23				0	Intro to flipped learning
W Aug 25		1.1	HW1	1	Elasticity
F Aug 27		1.2			
M Aug 30		2.1		2	Dislocations
W Sept 01		2.2	HW2		
F Sept 03		2.3			
M Sept 06					*no class* Labor Day
W Sept 08		3.1	HW3	3	Plasticity - Single Crystals
F Sept 10		3.2			
M Sept 13		4.1		4	Plasticity - Polycyrstals
W Sept 15		4.2	HW4		
F Sept 17	**1**				*Quiz 1* - Elasticity & Dislocations
M Sept 20		5.1		5	Strengthening
W Sept 22		5.2	HW5		
F Sept 24		5.3	FP1		*Project* planning meeting #1
M Sept 27		6.1		6	Engineering Failure
W Sept 29		6.2	HW6		
F Oct 01	**2**				*Quiz 2* - Plasticity & Strengthening
M Oct 04		7.1		7	Fracture - Linear Elastic
W Oct 06		7.2	HW7		
F Oct 08		8.1		8	Fracture - Brittle
M Oct 11		8.2			
W Oct 13		8.3	HW8		
F Oct 15	**3**				*Quiz 3* - Engineering Failure & LEFM
M Oct 18		9.1		9	Fracture - Cleavage
W Oct 20		9.2	HW9		
F Oct 22		9.3	FP2		*Project* update meeting #2
M Oct 25		10.1		10	Fracture - Ductile
W Oct 27		10.2	HW10		
F Oct 29	**4**				*Quiz* - Brittle & Cleavage Fracture
M Nov 01		10.3			
W Nov 03		11.1	HW11	11	Fatigue - Introduction
F Nov 05		11.2			
M Nov 08		12.1		12	Fatigue - Mechanisms
W Nov 10		12.2	HW12		
F Nov 12	**5**				*Quiz* - Ductile Fracture
M Nov 15		12.3			
W Nov 17		12.4	HW13		
F Nov 19			FP3		Flex day; *Project* update meeting #3
			— fall break —		
M Nov 29					Flex day
W Dec 01					Flex day
F Dec 03	**6**				*Quiz* - Fatigue
M Dec 06			FP4		Final Project Presentations
W Dec 08					Final Project Presentations
Th Dec 09		—		—	Reading Day
F Dec 10	**F**				1:30-4:30pm, final exam