

Schedule: MWF 11:00am-11:50am in 106B8 Engineering Hall

Course websites:

- Class schedule, announcements, lecture slides, gradebook, and homework deposit: compass2g.illinois.edu
- Online discussion forums: <https://piazza.com/illinois/fall2016/mse440/home>

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, viscoelastic 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.

Prerequisites: MSE 406 (Mechanical Behavior of Materials)

Instructor: Jessica Krogstad (jakrogst@illinois.edu; 168 MRL) *Office hours:* TR 12:00pm-1:00pm or by appointment; those attending office hours will work together to update the Piazza discussion board in real time to widely distribute questions and insight

Teaching Assistants:

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.

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. 7.

Course evaluation:

$$3\% \times (\text{Participation}) + 15\% \times (\text{Homework}) + 17\% \times (\text{Written Assignments and Final Project}) + 40\% \times (\text{Quizzes}) + 25\% \times (\text{Final Exam}) = \text{Total}$$

Participation (3%): Participation is qualitatively based on participation in class discussion and activities and will be quantitatively measured by completion of a daily *exit ticket* at the end of each regular lecture. These *exit tickets* will not be graded for accuracy but will count towards attendance. Students may skip up to three *exit tickets* before the participation grade is impacted; after that 1% will be deducted from the participation grade for each one missed.

Homework (15%): Homework is assigned and collected weekly on Wednesdays at the beginning of class and returned by the following Wednesday. No late homework will be accepted. In some instances, homework will be submitted through the COMPASS2G website and specific instructions will be provided with those assignments.

Written Assignments and Final Project (17%): Over the course of the semester, students will explore a materials application with relevance to the course material as determined by the instructor. This will culminate in a student poster session held during the class period on Monday December 5th. The posters 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.

All projects will begin as individual projects, but students may team up if complementary teams (i.e. some students interested in computational approaches and others interested in experimental approaches to the same issues within a given materials system) can be identified by mid-semester. Team development must be approved by the instructor and it should be noted that the expectations will scale with the size of the team. There will be 5 major milestones over the course of the semester:

1. Critical reading assignment #1: A 1 page written report will be submitted demonstrating basic familiarity with the system and failure modes and will include a comprehensive bibliography (not included in the 1 page limit).
2. Critical reading assignment #2: A 2 page written report will be submitted including an overview of the field (based on the previously submitted bibliography), connections to class and an outlook on the direction of the field.
3. Design project working day: An in-class working day to reflect on critical reading #2, potential team formation and brainstorming for experiment or model design.
4. Design project proposal: A 2 page written report will be submitted outlining an experiment or modeling approach designed by the student or team of students to address a specific challenge in the materials system.
5. Poster presentation: A digital copy of the poster must be submitted via COMPASS2G. In addition to specifically addressing the 4 points outline above, the poster will also be evaluated on the basis of clarity & presentation style.

Quizzes (40%): Quizzes will take place during the first 25 minutes of class approximately every other Friday (see calendar for details). Students arriving more than 15 minutes late, or after the first quiz is turned in whichever is first, will not be allowed to start the quiz. Make-up quizzes will be at the discretion of the instructor and will be conducted through oral examination not more than one week after the scheduled date of the missed quiz.

Final Exam (25%): A comprehensive final exam will be held Monday, December 12 from 7-10PM, location TBD.

Grade Reporting: All assessment scores are stored on the COMPASS2G website. Any errors in grade reporting appearing on COMPASS2G 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

- review the suggested reading material *before* coming to class, and formulate questions;
- participate in the class;
- make sure you understand the homework problems and solutions;
- seek out help when you have trouble.

Obtaining help: The main two ways to obtain help are online at Piazza or in person during office hours. You can also speak with your professor briefly after lecture. Please do not send email directly to TAs or professors 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 (Piazza): This class uses Piazza for all communication between the instructor, TAs, and students. Please visit piazza.com/illinois/fall2016/mse440/home to register. The class link will take you to the current class page at any time. Official class announcements will be sent via Piazza, so you must register with an email address that you regularly check. If you desire, you can post anonymously on Piazza or make a private post just to the instructors (this should be done rather than emailing the professor directly). You can also use the "Search for Teammates" feature on Piazza to help find a study group. *Note that Piazza should be used to communicate with your instructors, rather than email.*

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

1. Excuses from assessments will only be given in the following circumstances:
 - (a) Illness.
 - (b) Personal crisis (e.g., car accident, required court appearance, death of a close relative).
 - (c) 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.
3. In cases (a) or (b) an official excuse letter from the Dean on Duty must be submitted via the online form within 2 weeks of the due date of the missed assessment, but no later than reading day (December 8). In cases of extended or unusual illness, late submission of excuse documentation will be considered. See [Student Assistance Center](#).
4. In case (c) 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.
5. 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. Excused quizzes will be replaced by a weighted average of the other quiz scores at the end of semester.
6. 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.

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

| Week | Day | Date | Lecture Topic | Reading Assignment | | Evaluation | | |
|------|-----|--------|---|--------------------|---------------|--|-------------------------------------|---------------------|
| | | | | Book | Ch | Homework | Quizzes | Design Project |
| 1 | M | 22-Aug | Syllabus overview & course goals | | | | | |
| | W | 24-Aug | Elasticity Review | MC | 2.1-2.9 | HW1 - Pretest | | |
| | F | 26-Aug | Dislocations | C | 3 | | | |
| 2 | M | 29-Aug | Plastic deformation | C | 4.1-4.6 | | | |
| | W | 31-Aug | Strengthening | C | 5.1-5.9 | HW2 - Elasticity & dislocations | | |
| | F | 2-Sep | Strengthening | | | | | |
| 3 | M | 5-Sep | Labor Day - No classes | | | | | |
| | W | 7-Sep | Creep - plasticity & strain rate sensitivity | MC | 3.2, 3.7, 3.9 | HW3 - Plasticity & strengthening | | |
| | F | 9-Sep | Creep - intro | C | 7.1-2 | | Quiz 1 - Elasticity & dislocations | |
| 4 | M | 12-Sep | Creep - diffusion based mechanisms | C | 7.3A-C | | | |
| | W | 14-Sep | Creep - combining mechanisms | C | 7.3D-7.4 | HW4 - CM #1: Strain rate sensitivity | | |
| | F | 16-Sep | Creep - combining mechanisms | | | | | |
| 5 | M | 19-Sep | Creep - Experimental methods & Intro to superplasticity | H | 5.6 | | | |
| | W | 21-Sep | Creep - Superplasticity & hot working | C | 7.7-9 | HW5 - Creep #1 | | |
| | F | 23-Sep | Fracture - Case studies | | | | Quiz 2 - Plasticity & strengthening | |
| 6 | M | 26-Sep | Fracture - Intro | A | 2.1;1.3.1-2 | | | |
| | W | 28-Sep | Fracture - Geometry | A | 2.2-2.6 | HW6 - Creep #2 | | |
| | F | 30-Sep | Fracture - Brittle fracture | MC | 7.10 | | | Critical Reading #1 |
| 7 | M | 3-Oct | Toughening - Intro | A | 6.2 | | | |
| | W | 5-Oct | Toughening - Ceramics | A | 6.2 | HW7 - Intro to fracture | | |
| | F | 7-Oct | Fracture - Cleavage | A | 5.2 | | Quiz 3 - Creep | |
| 8 | M | 10-Oct | Fracture - DBTT | A | 5.1, 7.4 | | | |
| | W | 12-Oct | Fracture - Ductile fracture | A | 5.1-2 | HW 8 - CM #2: Thermally induced fracture | | |
| | F | 14-Oct | Fracture - Ductile fracture | A | 3.1-2 | | | |
| 9 | M | 17-Oct | Fracture - Ductile fracture | A | 3.1,2,5; 7.4 | | | |
| | W | 19-Oct | Fracture - Testing | H | 9.1-2 | HW9 - Toughening | | |

| | | | | |
|------|--------|---|-----------------------|--|
| F | 21-Oct | Fracture - Composites | Marshall1985 & A6.1.3 | Quiz 4 - Toughening |
| 10 M | 24-Oct | Fracture - Composites | Marshall1985 | |
| W | 26-Oct | High-Temperature Fracture | Vehoff1994 | HW10 - Cleavage & ductile fracture |
| F | 28-Oct | Embrittlement - Intro | | Critical Reading #2 |
| 11 M | 31-Oct | Design Project working day | | In-Class Working Day |
| W | 2-Nov | Quiz 5 only (no new material) | | HW 11 - Fracture testing & composites* Quiz 5 - Cleavage & ductile fracture, fracture testing |
| F | 4-Nov | Embrittlement - Hydrogen | C 13.1-2 | |
| 12 M | 7-Nov | Embrittlement - Stress corrosion cracking | C 13.3A-C | |
| W | 9-Nov | Embrittlement - Life prediction | C 13.4-6 | No HW |
| F | 11-Nov | Fatigue - Case studies | | |
| 13 M | 14-Nov | Fatigue - Fractography & terminology | H 12.1 | |
| W | 16-Nov | Fatigue - Experiments | H 12.2-2.2 | HW 13 - Embrittlement |
| F | 18-Nov | Fatigue - Intro to mechanisms | MC 14.5 | Quiz 6 - Fracture: Composites & Hi-T Design Proposal |
| 14 M | 21-Nov | Thanksgiving Break | | |
| W | 23-Nov | Thanksgiving Break | | |
| F | 25-Nov | Thanksgiving Break | | |
| 15 M | 28-Nov | Fatigue - Mechanisms & crack growth | MC 14.5 | |
| W | 30-Nov | Fatigue - Design & microstructural considerations | H 12.6 | |
| F | 2-Dec | Corrosion-fatigue & Creep fatigue interactions | S 16 | HW14 - Fatigue |
| 16 M | 5-Dec | Design Project Poster Session (In-Class) | | Poster Presentation |
| W | 7-Dec | Exam Review | | HW15 - Corrected pretest |
| 17 M | 12-Dec | Final Exam: 7-10PM | | |

Run > Hide > Fight

Emergencies can happen anywhere and at any time. It is important that we take a minute to prepare for a situation in which our safety or even our lives could depend on our ability to react quickly. When we're faced with any kind of emergency – like fire, severe weather or if someone is trying to hurt you – we have three options: Run, hide or fight.



Run

Leaving the area quickly is the best option if it is safe to do so.

- ▶ Take time now to learn the different ways to leave your building.
- ▶ Leave personal items behind.
- ▶ Assist those who need help, but consider whether doing so puts yourself at risk.
- ▶ Alert authorities of the emergency when it is safe to do so.



Hide

When you can't or don't want to run, take shelter indoors.

- ▶ Take time now to learn different ways to seek shelter in your building.
- ▶ If severe weather is imminent, go to the nearest indoor storm refuge area.
- ▶ If someone is trying to hurt you and you can't evacuate, get to a place where you can't be seen, lock or barricade your area, silence your phone, don't make any noise and don't come out until you receive an Illini-Alert indicating it is safe to do so.



Fight

As a last resort, you may need to fight to increase your chances of survival.

- ▶ Think about what kind of common items are in your area which you can use to defend yourself.
- ▶ Team up with others to fight if the situation allows.
- ▶ Mentally prepare yourself – you may be in a fight for your life.

Please be aware of persons with disabilities who may need additional assistance in emergency situations.

Other resources

- ▶ police.illinois.edu/safe for more information on how to prepare for emergencies, including how to run, hide or fight and building floor plans that can show you safe areas.
- ▶ emergency.illinois.edu to sign up for Illini-Alert text messages.
- ▶ **Follow the University of Illinois Police Department** on Twitter and Facebook to get regular updates about campus safety.