MECHANICAL BEHAVIOR OF ENGINEERING MATERIALS
ME 562 / MSE 562
Spring 2025

Tuesday and Thursday 10:05 – 11:30 am, ES 1337

Instructor: Prof. Junghyun Cho
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Office Hour: Tuesday 4:30 – 5:30 pm
(ES 1307) Thursday 4:30 – 5:30 pm
Or by e-mail appointment

Course Description: This course will focus on the relationships between the structure of materials and their mechanical responses. Elastic and plastic deformation of a variety of materials including metals, ceramics, and polymers, and their testing methods will be discussed. Macroscopic and microscopic concepts of strength, creep and fracture will be covered. Students are expected to have some familiarity with concepts of stress and strain, basic principles of elasticity, and introductory materials science.

Course Objectives:
- Learn the structure-property relationships of materials
- Use crystal structure and microstructure to interpret and predict mechanical behavior of materials
- Understand 'imperfections' in crystals
- Identify mechanical testing for various applications of metals, ceramics, and polymers

Prerequisite: introduction to materials science, solid mechanics (at undergraduate level)

Credits Allocated: 3 credits

Assignments: about 9 assignments per semester, each assignment equally graded

Method of Assessing Student Achievement: all assignments will be collected, graded, and distributed with the scores and feedback (via Brightspace, 20% total). Two exams will be given (80% total); the first exam is a mid-term exam that will be given in class and returned with the scores and feedback, and the second exam is a final exam and will contain the entire topics covered in class.

Basis of Grade Determination:
- Homework: 20%
- Midterm Exam: 40%
- Final Exam: 40%

Bibliographic and Other Resources:

Required Textbook

• G. E. Dieter, Mechanical Metallurgy, 3rd Ed, McGraw-Hill, 1986.

Other Useful References

• W. D. Callister and D. G. Rethwisch, Materials Science and Engineering, An Introduction, 9th Ed, Wiley, 2014

• M. A. Meyers and K. K. Chawla, Mechanical Behavior of Materials, Prentice Hall, 1999. • T. H. Courtney, Mechanical Behavior of Materials, 2nd Ed., McGraw-Hill, 2000. • R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 4th Ed, John Wiley & Sons, Inc., 1996.

• H. J. Frost and M. F. Ashby, Deformation-Mechanism Maps, Pergamon Press, 1982. • D. Hull and D. J. Bacon, Introduction to Dislocations, 5th Ed, Pergamon Press, 2011. (eBook available at the library site)

Other Course Policies Related to Integrity of Credit:

• **No late homework assignments** will be accepted.

• **No make-up exams** will be given for the scheduled exams.

• Minimum class attendance (over 80%) is required to pass the course.

• Assignments, schedules, and announcements will be posted on the *Brightspace*. • **Student conduct:** Students are expected to conduct themselves according to the ethical standards set forth by the University in the Student Handbook, available at: https://www.binghamton.edu/student-handbook/

• **Academic misconduct**, whether on homework or exams will be dealt strictly. Consequences may vary from a score of "0" on an assignment involving the transgression to a grade of "F" for the course. Punitive actions shall be decided by the instructor, with consultation from the Department Chair.

• **Note regarding homework**: Working together and discussing homework assignments are encouraged, and are beneficial to learning. However, any work turned in by a student for course credit MUST be that student's OWN work and not a copy of someone else's work. Copies of another student's work will result in scores of "0" for the original author and the copier.

Core Topics:

Dates	**Topic**	**Reading**
Jan 21, 23	Overview Elasticity (I) – stress/strain	**PPT slides** **Dieter Ch.2**
Jan 28, 30	Elasticity (I) – tensor	**Dieter Ch.2** Meyers Ch.1, 2

Feb 4, 6	Elasticity (II) – anisotropy	**Dieter Ch.2** Meyers Ch.1, 2
Feb 11, 13	Plasticity (I) – flow curve, tensile testing, yielding criteria	**Dieter Ch.3** Meyers Ch.3
Feb 18, 20	Plasticity (II) – other tests	**Dieter Ch.3, 8, 9, 10** Meyers Ch.3
Feb 25, 27	Imperfections (I) – slip, theoretical shear strength, dislocation topography	**Dieter Ch.5** Meyers Ch.4; Hull

Mar 4, 6	Imperfections (II) – dislocation elasticity: strain, stress, strain energy	**Dieter Ch.5** Meyers Ch.4; Hull
Mar 11, 13	**Spring break from Mar 8-16 (no class)**	
Mar 18	Imperfections (III) – dislocation motion, intersection, sources, pile-ups	**Dieter Ch.5** Meyers Ch.4; Hull
Mar 20	**(1) Mid-term Exam**	
Mar 25, 27	Plastic deformation of single crystals (I) – slip deformation	**Dieter Ch.4** Myers Ch.6
Apr 1, 3	Plastic deformation of single crystals (II) – effect of crystal struct.; twinning	**Dieter Ch.4** Myers Ch.6
Apr 8, 10	Strengthening mechanisms – strain, polycrystals, alloying, particles, fibers	**Dieter Ch.6** Meyers Ch.10
Apr 15, 17	Creep (I) – time-dependent mechanical deformation	**Dieter Ch.13** Meyers Ch.13; Frost
Apr 22	**Monday class meets (no class)**	
Apr 24	Creep (II) – deformation mechanisms, superplasticity	**Dieter Ch.13** Meyers Ch.13; Frost
Apr 29, May 1	Fracture (I) – general overview	**Dieter Ch.7;** Hertzberg Ch.8; Meyers Ch.8,9; Courtney Ch.10
May 6	Fracture (II) – fracture mechanics	**Dieter Ch.11;** Hertzberg

		Ch.8; Meyers Ch.8,9; Courtney Ch.10
May 9-15	**(2) Final Exam (cumulative): date and time to be announced by university**	