New Course EFD Template

PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document No.:
EFD# 67-26
October 31, 2025

TO: The Engineering Faculty

FROM: The Faculty of the School of Mechanical Engineering

RE: Renew graduate course – ME56900 Mechanical Behavior of Materials

The Faculty of the School of Mechanical Engineering has approved the following renewal of a graduate course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM (IF ALREADY OFFERED WITH TEMPORARY NUMBER):

ME 56900

Spring

3 total credits;

Graduate standing, Undergraduate Senior in Mechanical Engineering

TO:

ME 56900

Fall (first offering Fall 2026 PEO only), then Fall (in person and PEO)

3 total credits;

Graduate standing, Senior in Mechanical Engineering

A study of load and environmental conditions that influence the behavior of materials in service. Elastic and plastic behavior, fracture, fatigue, low and high temperature behavior. Fracture mechanics. Failure analysis case studies emphasis on design

RATIONALE:

This course was offered in the past (Ben Hillberry) and this document requests to renew this course. The course description is not changed but emphasis and delivery of content is adapted to current technology. The realization of engineering systems is inherently related to the understanding of mechanical properties of materials.

Head/Director of the School of Mechanical Engineering

Link to Curriculog entry: https://purdue.curriculog.com/proposal:34748/form

ME 569: Mechanical Behavior of Materials

Course Information

Course name: Mechanical Behavior of Materials ME 589
Teaching Modality: Asynchronous online

- All course material is provided as a combination of (1) video recording, (2) slides, (3) case studies, and (4) required and suggested reading. Quizzes and assignments to be completed on a periodic schedule. Three midterm exams.

Websites:

- ME569 Brightspace (lecture videos, notes, case studies, quizzes).
- ME569 Gradescope (assignment and exam submission).
- ME569 Piazza (discussion)

Instructor & TA Contact Information

- Instructor: Thomas Siegmund
  - Phone: 765-494-9766
  - Piazza is the primary tool of communication. Email: siegmund@purdue.edu
- TA: See Brightspace for TA and office hour schedule.

Course Description

This course considers the mechanical loads and environmental conditions that influence the behavior of materials in service. Elastic and plastic behavior, fracture, fatigue, low and high temperature behavior. Fracture mechanics. Analysis case studies emphasis on material selection and design. Considers metals, elastomers, ceramics.

Three major topics are covered:

1. Chapter 1: Material Spaces and Properties, Design Considerations, Material Selection
2. Chapter 2: Metallic materials
3. Chapter 3: Ceramics
4. Chapter 4: Elastomers

Prerequisites

- Good standing in graduate program

Course Learning Outcomes (CLOs)

By the end of this course, students will be able to:

Knowledge & Comprehension:

1. CLO 1: Identify deformation and failure in metallic materials (modulus, yield, strength, toughness, creep) and be able to relate behavior to microscale processes and dislocations.
2. CLO 2: Identify deformation and failure in ceramic materials (modulus, strength, damage toughness) and be able to relate behavior to microscale processes and damage evolution
3. CLO3: Identify deformation and failure in elastomeric materials (nonlinear elasticity, viscosity) and be able to relate behavior to microscale processes and molecular processes

Knowledge & Application:

1. CLO 4: Analyze problems in mechanics of materials, interpret technical literature, and write technical report about a problem in this field.

Synthesis:

1. CLO 5: Explain material selection charts in the context of mechanical properties and design objectives to apply mechanics of materials principles to real world engineering applications and design.

Learning Resources, Technology, & Texts

- Videos, slides, case studies provided by the instructor
- ***Suggested Texts (available for free online):***
  - *Materials selection in mechanical design*, M. Ashby, 2010, 4th Edition, online access available via Purdue Libraries.
  - *Mechanical Behavior of Materials,* R.S. Mishra, I. Charit, R. Sankar Haridas, 2026, 1st Edition Online access available via Purdue Libraries.
  - *Engineering Damage Mechanics: Ductile, Creep, Fatigue and Brittle Failures*, J. Lemaitre, R. Desmorat 2005, online access available via Purdue Libraries.
- ***Reference Text for Solid Mechanics in General:***
  - Applied Mechanics of Solids, A. Bowers.
- ***Software:***
  - Scanner or Smartphone with photo/scanner app.
  - General office productivity software (Word, Excel, or equivalent).

Assignments and Exams

Your learning will be assessed through a combination of participation (quizzes), analysis assignments, writing assignments, and three exams spread throughout the academic period. Details on these assignments and exams, including a schedule of due dates will be posted in Brightspace:

Assignments	Due	Points
Participation	14 quizzes (weekly, for each module)	14 x 5 pts = 70 pts
Analysis Assignments	7 assignments (biweekly)	7 x 30 pts = 210 pts
Writing Assignments	2 assignments	2 x 60 pts = 120 pts
Exam #1	Course Content Modules 1-4	100 pts
Exam #2	Course Content Modules 5-10	100 pts
Exam #3	Course Content Modules 11-15	100 pts
		Total: 700 pts

- **Participation** (70 points). Participation points can be earned each week through quizzes that you will complete in Brightspace.
- **Analysis Assignments** (210 points). These assignments relate to course learning objectives and involve work to enhance your understanding and ability to complete the fundamental skills of the class. Submitted via Gradescope.
- **Writing Assignments** (120 points). These assignments relate to course learning objectives and involve structured writing assignments. Submitted via Gradescope.
- **Exam #1** (100 points).
- **Exam #2** (100 points).
- **Exam #3** (100 points).

- *Refer to the Course Schedule in Brightspace for specific dates*.

Exam format: Each midterm exam is 60 minutes timed. The exam is proctored by honorlock software. A calculator conforming to ME calculator policy is allowed. Exams are to be completed by pen/paper. The use of tablets is not accepted (except with accommodations from DRC).

Please read the feedback that I provide for ways to enhance your grade going forward and consult with me if you find yourself struggling to participate so we can develop appropriate strategies together.

Related considerations:

1. For the schedule of due dates see the *Course Schedule* in Brightspace.
2. Late assignments will be accepted only if prior notice is provided to the instructor and for reasons such as health concerns or other significant events.
3. Make-up exams will be given only if prior notice is provided to the instructor and for reasons such as health concerns or other significant events.

Grading Scale

In this class, grades reflect the sum of your achievement throughout the semester. You will accumulate points as described in the assignments portion above, with each assignment graded according to a rubric. At the end of the semester, final grades will be calculated by adding the total points earned and translating those numbers (out of 700) into the letters. A percentage-based system and a straight grading scale will be used:

- A+: 97-100
- A: 93-96.9
- A-: 90-92.9
- B+: 87-89.9
- B: 83-86.9
- B-: 80-82.9
- C+: 77-79.9
- C: 73-76.9
- C-: 70-72.9
- D+: 67-69.9
- D: 63-66.9
- D-: 60-62.9
- F: 59.9 and below

Academic dishonesty will significantly affect a course grade. No points will be given for assignments and exams in which a case of academic dishonesty is determined.

Course Content

Chapter 1 Mechanical Behavior of Materials: General Aspects

- Week/Module 1: Introduction to Mechanics of Materials, natural resources
- Week/Module 2: Material property charts, Material efficiency and material properties

Chapter 2 Mechanical Behavior of Metals

- Week/Module 3: Metals: elastic, plastic response
- Week/Module 4: Metals: Dislocations and plasticity
- Week/Module 5: Metals: High temperatures, creep; cyclic loading, fatigue
- Week/Module 6: Metals: Fracture mechanics; crack growth in metals
- Week/Module 7: Metals: Fatigue crack growth and fatigue crack growth failure, Environment

Chapter 3 Mechanical Behavior of Ceramics

- Week/Module 8: Ceramics: elastic and nonlinear response, tensile test, environmental effects
- Week/Module 9: Ceramics: Damage mechanics and mechanism
- Week/Module 10: Ceramics: Cracks and stability; strength as an apparent property

Chapter 4 Mechanical Behavior of Elastomers

- Week/Module 11: Elastomers: large strain response
- Week/Module 12: Elastomers: polymer chain mechanics and elasticity
- Week/Module 13: Elastomers: Hysteresis and time dependence, environmental effects

Summary:

- Week/Module 14: Material design revisited; empty spaces in material charts

Estimated Effort

- 1 module each week
- 14 modules total

Course Discussion and Guidelines

For this course we use Piazza as our online discussion tool. This is the best way to communicate with the instructor and TAs.

Please follow the Discussion Guidelines when contributing to discussions in this course. Here are a few of the key points you should remember:

- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular or slang language. This could possibly lead to misinterpretation.
- Do not hesitate to ask for feedback.
- Be concise and to the point.
- Think and edit before you push the “Send” button.

Course Schedule

Week	Content	Assignments	Assignments Due	Quizzes	Exams
1	**Module 1**	Analysis Assignment 1		Quiz 1 Due: 11:59 PM ET, Su	
2	**Module 2**	Writing Assignment 1	Analysis Assignment 1 Due: 11:59 PM ET, Su	Quiz 2 Due: 11:59 PM ET, Su	
3	**Module 3**	Analysis Assignment 2		Quiz 3 Due: 11:59 PM ET, Su	
4	**Module 4**		Analysis Assignment 2 Due: 11:59 PM ET, Su	Quiz 4 Due: 11:59 PM ET, Su	
5	**Module 5**	Analysis Assignment 3	Writing Assignment 1 Due: 11:59 PM ET, Su	Quiz 5 Due: 11:59 PM ET, Su	
6	**Module 6**		Analysis Assignment 3 Due: 11:59 PM ET, Su	Quiz 6 Due: 11:59 PM ET, Su	**Midterm Exam 1**
7	**Module 7**	Analysis Assignment 4		Quiz 7 Due: 11:59 PM ET, Su	
8	**Module 8**		Analysis Assignment 4 Due: 11:59 PM ET, Su	Quiz 8 Due: 11:59 PM ET, Su	
9	**Module 9**	Analysis Assignment 5 Writing Assignment 2		Quiz 9 Due: 11:59 PM ET, Su	
10	**Module 10**		Analysis Assignment 5 Due: 11:59 PM ET, Su	Quiz 10 Due: 11:59 PM ET, Su	
11	**Module 11**	Analysis Assignment 6		Quiz 11 Due: 11:59 PM ET, Su	**Midterm Exam 2**
12	**Module 12**		Analysis Assignment 6 Due: 11:59 PM ET, Su	Quiz 12 Due: 11:59 PM ET, Su	

Week	Content	Assignments	Assignments Due	Quizzes	Exams
13	**Module 13**	Analysis Assignment 7	Writing Assignment 2 Due: 11:59 PM ET, Su	Quiz 13 Due: 11:59 PM ET, Su	
14	**Module 14**		Analysis Assignment 7 Due: 11:59 PM ET, Su	Quiz 14 Due: 11:59 PM ET, Su	
15	**Module 15**				**Midterm Exam 3**

NOTE: Color Codes Refer to Modules Covered by the Respective Exam

There are three midterm exams and no comprehensive Final Exam

Academic Integrity and Copyright

Academic integrity is one of the highest values that Purdue University holds. As a Purdue student you subscribe to the Purdue Honor Pledge:

"As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - We are Purdue."

- All assignments and exams must be your individual work and cannot be completed or submitted by others or surrogates.
- **Exams** must be completed fully individually without any on-time consultation of others or of any electronic resources not specifically listed in the exam guidelines. All exams are available online during predefined timeslots.
- **Assignment submissions and quizzes responses** must be completed and submitted individually. However, you are allowed to consult with others in the class and use external and course related resources to complete the assignments.
- Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered.

Purdue University's Student Conduct Rules
https://catalog.purdue.edu/content.php?catoid=16&navoid=19689&_ga=2.197042858.76024265.1702163117-387856188.1701722407#regulations-governing-student-conduct-disciplinary-proceedings-and-appeals state:

i. *Cheating: Students are expected to adhere to the guidelines provided by instructors for academic work so that no student gains an unfair advantage. Using or attempting to use unauthorized materials, information, study aids, notes, or any other device in any academic exercise will not be tolerated. Unauthorized materials may include anything which or anyone who gives a student assistance that has not been approved by the instructor in advance.*
ii. *Plagiarism: Intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise, without proper attribution. The sole exception of the requirements of acknowledging sources is when the information is considered common knowledge. Plagiarism includes "self-plagiarism", which is reusing portions of the student's previously written text and/or assignments, without acknowledgement or proper attribution.*
iii. *Fabrication: Intentional and/or unauthorized falsification or invention of any information or citation in any academic exercise. Includes but is not necessarily limited to (A) the*

changing and/or manipulation of research data, results, processes, or research record; (B) the omission of results from the research record; and (C) the alteration and resubmission of a graded academic exercise.

iv. *Multiple Submissions: The submission of substantial portions of the same academic work for credit more than once without authorization from the instructor.*

v. *Collusion: Intentionally or knowingly helping or attempting to help another to violate any regulation governing the standards of academic integrity described in these regulations. Students may only collaborate on academic work within the limits prescribed by the instructor.*

Copyright: Lecture materials, as well as videos provided by the instructor are subject to the instructor's copyright. Course notes are considered to be 'derivative works' of the instructor's presentations and materials, and they are thus subject to the instructor's copyright. This instructor does not give permission for any such material to be sold or bartered. This includes uploads to commercial note sharing websites (including, but not limited to, CourseHero and Chegg).
Software: If accessing software through Purdue University, follow all respective license agreements.

AI: ***The use of AI tools to complete course assignment is not allowed and students are expected to complete all assignments and deliverables as part of their own personal effort.*** If the use of AI is detected as part of submitted solutions, grades will be invalidated, and the conduct be treated as violation of academic honesty.

Attendance Policy

Medically Excused Absences (MEAPS): A student can contact the Office of the Dean of Students (ODOS) to request that a notice of the leave be sent to instructors when a situation involving **hospitalization, emergency department or urgent care visits emerges**. The student can then provide documentation of hospitalization, emergency department or urgent care as proof of legitimate absence to the ODOS as soon as these documents are available.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. More details are available on our course Brightspace table of contents, under *University Policies*. A link to Purdue's nondiscrimination policy is included in Brightspace and can be found here: *Link to Purdue's nondiscrimination policy statement*.

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under *Student Help and Success*.

Mental Health Statement

During the semester it is always a possibility that there are reasons that you might find yourself overwhelmed with academic demand and/or personal matter.

- **If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack.** Sign in and find information and tools at your fingertips, available to you at any time.
- **If you need support and information about options and resources**, please see the Office of the Dean of Students for drop-in hours (M-F, 8 am- 5 pm).
- **If you're struggling and need mental health services**: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructor via email. You are expected to read your email on a frequent basis.

ME 56900
Mechanical Behavior of Materials

Course Outcomes

1. Identify deformation and failure processes in metallic, ceramic and elastomeric materials
2. Relate deformation and failure modes to microscale processes
3. Analyze problems in mechanics of materials, interpret technical literature, and write technical reports
4. Explain material selection charts in the context of mechanical properties and design objectives

[1] Introduction (2 wks)

1. Course context
2. Historial aspects of material use
3. Material resources
4. Material Design
5. Empty spaces in material property charts

[2] Material Property Charts (1.0 wks)

1. Material property charts.
2. Material efficiency.
3. Material properties of relevance

[3] Metals – Properties (3 wks)

1. Elasticity, plasticity
2. Tensile test.
3. Fatigue
4. Creep
5. Fracture
6. Fatigue crack growth
7. Environmental effects

[4] Metals – Microscale Processes (2 wks)

1. Dislocations
2. Dislocations and plasticity

[5] Ceramics - Properties (2 wks)

1. Elasticity and strength
2. Nonlinear behavior and microcracks
3. Tensile test
4. Environmental effects

[6] Ceramics – Microscale Processe (1 wk).

1. Damage mechanics
2. Damage evolution.
3. Uniaxial and multiaxial conditions
4. Strength and size effects

[7] Elastomers - Properties (2 wk)

1. Elastic and nonlinear elastic behavior
2. Large strain response
3. Hysteresis.
4. Rate dependence.
5. Environmental effects

[8] Elastomers – Microscale Processes (1 wk)

1. Polymer chain mechanics
2. Polymer chains mechanics and nonlinear elasticity.

Revision Date: 09/024/25

COURSE NUMBER: ME 56900 **COURSE TITLE:** Mechanical Behavior of Materials

REQUIRED COURSE OR ELECTIVE COURSE: Elective

TERMS OFFERED: Fall 2026 and subsequent.

TEXTBOOK/REQUIRED MATERIAL: Lecture notes; *Materials selection in mechanical design*, M. Ashby, 2010, 4th Edition; *Mechanical Behavior of Materials,* R.S. Mishra, I. Charit, R. Sankar Haridas, 2026, 1st Edition; *Engineering Damage Mechanics: Ductile, Creep, Fatigue and Brittle Failures*, J. Lemaitre, R. Desmorat 2005. Selected publications

PRE-REQUISITES:

- Graduate Student in good standing
- Undergraduate: ME 323: Mechanics of Materials, or equivalent

COORDINATING FACULTY: Thomas Siegmund

COURSE DESCRIPTION:
A study of load and environmental conditions that influence the behavior of materials in service. Elastic and plastic behavior, fracture, fatigue, low and high temperature behavior. Fracture mechanics. Failure analysis case studies emphasis on design.

COURSE OUTCOMES:

1: Identify deformation and failure in metallic materials (modulus, yield, strength, toughness, creep) and be able to relate behavior to microscale processes and dislocations.
2: Identify deformation and failure in ceramic materials (modulus, strength, damage toughness) and be able to relate behavior to microscale processes and damage evolution
3: Identify deformation and failure in elastomeric materials (nonlinear elasticity, viscosity) and be able to relate behavior to microscale processes and molecular processes
4. Analyze problems in mechanics of materials, interpret technical literature, and write technical report about a problem in this field.
5. Explain material selection charts in the context of mechanical properties and design objectives to apply mechanics of materials principles to real world engineering applications and design.

ASSESSMENTS TOOLS:

- Three midterm exams (42%)
- Biweekly assignments (30%)
- Two writing assignment (18%)s
- Weekly quizzes (10%)

PROFESSIONAL COMPONENT:
Engineering Topics: Engineering Science – 2.0 credit (70%)
Engineering Design – 1.0 credit (30%)

NATURE OF DESIGN CONTENT:

- Design of structures under consideration of deformation and failure behavior of materials (metals, ceramics, elastomers)
- Material selection for design problems.

RELATED ME PROGRAM OUTCOMES:

1. Engineering fundamentals
2. Engineering design
3. Experimental skills
4. Teamwork skills
5. Communication skills
6. Ethical/ Professional Responsibilities
7. Knowledge acquisition

COMPUTER USAGE:

- NA

COURSE STRUCTURE/SCHEDULE:

- Asynchronous online (PEO
- Two lectures weekly (in person)

PREPARED BY: Thomas Siegmund **REVISION DATE**: Sept. 24, 2025