

Department of Materials Science and Engineering
University of Maryland, College Park, Maryland

ENMA 362: Mechanical Properties

Course Description: Overview of Mechanical Behavior, Elastic Behavior, Dislocations, Plastic Deformation, Strengthening of Crystalline Materials, Composite Materials, High Temperature Deformation of Crystalline Materials, Permanent Deformation of Noncrystalline Materials, Tensile Fracture at Low Temperatures, Engineering Aspects of Fracture, High Temperature Fracture, Fatigue, Embrittlement, and Experimental determination of Mechanical Properties including Hardness of Metals and Strength of Metals, Polymers, Ceramics and Composites.

Prerequisites: Permission of the department

Textbook: T. H. Courtney, "Mechanical Behavior of Materials," Second Edition, McGraw-Hill, 2000.

Course Objective: The main objective of this course is to teach how various factors such as chemical composition and microstructure affect mechanical properties of various engineering materials including metals, ceramics, polymers, and composite materials, and to teach the experimental methods to determine various mechanical properties of these engineering Materials. Satisfactory Completion of this course should demonstrate ability to:

1. Understand how the chemical composition and microstructure affect mechanical properties of various engineering materials.
2. Understand the ways to alter a materials' microstructure.
3. Learn how various factors such as temperature and strain rate affect the mechanical properties of a material.
4. Learn how to experimentally determine the mechanical properties of a material.
5. Analyze and interpret test data.

Course Goals to meet ABET 2005 Criteria:

1. Understand how composition and microstructure affect mechanical properties of various engineering materials.
2. Learn how various factors such as temperature and strain rate affect the mechanical properties of a material.
3. Learn how to experimentally determine the mechanical properties of a material and analyze and interpret test data.
4. Mechanical behavior in brittle, ductile and rubbery materials

Topics Covered:

- I. OVERVIEW OF MECHANICAL BEHAVIOR

- II. ELASTIC BEHAVIOR
 - Elastic Properties
 - Linear Elasticity
 - Rubber Elasticity
 - Viscoelasticity
 - Mechanical Damping

- III. DISLOCATIONS
 - Edge Dislocations
 - Screw and Mixed Dislocations
 - Twinning
 - Properties of Dislocations
 - Interaction of Moving Dislocations
 - Dislocation Density and Microscopic Strain

- IV. PLASTIC DEFORMATION IN SINGLE AND POLYCRYSTALLINE MATERIALS
 - Initiation of Plastic Flow in Single Crystals
 - Stress-Strain Behavior of Single Crystals
 - Plastic Flow in Polycrystals

- V. STRENGTHENING OF CRYSTALLINE MATERIALS
 - General Description of Strengthening
 - Work Hardening
 - Boundary Strengthening
 - Particle Hardening
 - Deformation of Two Phase Aggregates

- VI. COMPOSITE MATERIALS
 - Basic Principles
 - Reinforcement with Continuous Fibers
 - Reinforcement with Discontinuous Fibers
 - Reinforcement of Brittle Matrices
 - Modern Composite Materials

- VII. HIGH TEMPERATURE DEFORMATION OF CRYSTALLINE MATERIALS
 - Phenomenological Description of Creep
 - Creep Mechanisms
 - Engineering Aspects of Creep Design

- VIII. PERMANENT DEFORMATION OF NONCRYSTALLINE MATERIALS
 - Crystalline Versus Noncrystalline Structures
 - Viscosity
 - The Deformation Behavior of Inorganic Glasses

- IX. FRACTURE MECHANICS
 - The theoretical strength of a solid

Crack-initiated Fracture
Fracture Mechanics

- X. HIGH TEMPERATURE FRACTURE
High Temperature Fracture Modes
Failure in Superplastic Materials

- XI. FATIGUE OF ENGINEERING MATERIALS
Characteristics of Fatigue Fracture
Evaluation of Fatigue Resistance
Fatigue Crack Growth Rates
Polymeric Fatigue

- XII. EMBRITTLEMENT
Metal Embrittlement
Stress Corrosion Cracking
Hydrogen Embrittlement

- XIII. EXPERIMENTAL DETERMINATION OF MECHANICAL PROPERTIES
Metallographic Specimen Preparation
Optical Metallography
Hardness Measurement
Effects of Temperature on Ductility
Strength of Metals
Strength of Polymers
Strength of Ceramics
Strength of Composite Materials

Class Schedule:

Lecture: Monday, Wednesday: 1:00-2:15 PM, Room CHE 2120

Lab: Friday 2:00 – 4:00 pm, Room CHE 2140

Policies:

Homework: Homework assignments will be due at the beginning of class. Late homework will NOT be accepted.

Quizzes: Quizzes will be randomly given at the beginning of a class. If a student misses the quiz due to lateness or unexcused absence, a zero will be issued to that student for that quiz.

Attendance: Mandatory.

Academic Integrity: See <http://www.umd.edu/current/policies.html>

Safety: Safety procedures for a given lab will be presented at the beginning of that lab and must be attended in order to participate in the lab.

Grading:

Quizzes	10%
Homework	15%
Mid-Term Exam: October 22, 2003	25%
Intermediate Lab. Report (Due 10/31/03)	5%
Final Lab. Report (Due 12/12/03)	15%
Final Exam (Comprehensive) (December 16, 2003; 1:30-3:30 pm)	30%

Instructor: Prof. S. Ankem

Bldg. 090, Room 1105

Tel: (301) 405-5219

E-Mail: ankem@eng.umd.edu

Office Hours: M, W

11:00–12:00 noon

2:30-3:30 pm

Prepared by: Prof. Ankem, August 2003