MME 3407/5308/MASE6390 - MECHANICAL BEHAVIOR OF MATERIALS
(SPRING SEMESTER 2023)

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OFFICE: 201F Engineering Science Complex

TEXTBOOK: "**Mechanical Behavior of Materials**"
Marc A Meyers and Krishan Chawla
Cambridge University Press, 2009
ISBN 978-0-521-86675-0

CLASS TIMES:	Lecture	TR	1030 – 11:50	CBRL 205
	Lab	T	1:30 – 4:20	CBRL 205
		R	1:30 – 4:20	CBRL 205

COURSE SYLLABUS

NO.	CHAPTER	DATE	TOPIC
1	1	Jan 17	Materials Structure, Properties, and Performance
2	1	Jan 19	Materials Structure, Properties, and Performance
3	1	Jan 24	Materials Structure, Properties, and Performance
4	3	Jan 26	Plasticity
5	3	Jan 31	Plasticity
6	3	Feb 2	Plasticity
7	4	Feb 7	Imperfections: Point and Line Defects
8	4	Feb 9	Imperfections: Point and Line Defects
9	X	Feb 14	**EXAMINATION NO.1**
10	4/5	Feb 16	Imperfections: Point and Line Defects
11	4/5	Feb 21	Imperfections: Point and Line Defects/Interfacial and Volumetric
12	6	Feb 23	Geometry of Deformation
13	6	Feb 28	Geometry of Deformation
14	6	Mar 2	Geometry of Deformation
15	10	Mar 7	Solid Solutions, Precipitation and Dispersion Strengthening
16	10	Mar 9	Solid Solutions, Precipitation and Dispersion Strengthening
X	X	Mar 14	**SPRING BREAK**
X	X	Mar 16	**SPRING BREAK**
17	10	Mar 21	No Class - Solid Solutions, Precipitation and Dispersion Strengthening
18	X	Mar 23	**EXAMINATION NO.2**
19	13	Mar 28	Creep and Superplasticity
20	13	Mar 30	Creep and Superplasticity
21	13	Apr 4	Creep and Superplasticity
22	13	Apr 6	Creep and Superplasticity
23	X	Apr 11	**EXAMINATION NO.3**
24	14	Apr 13	Fatigue
25	14	Apr 18	Fatigue
26	14	Apr 20	Fatigue
27	14	Apr 25	Fatigue
28	21	Apr 27	Ductile Fracture
29	21	May 2	Ductile Fracture
30	X	May 4	**EXAMINATION NO.4**
X	X	May 11	**FINAL EXAMINATION THURSDAY 10:00 – 12:45**

GRADING POLICY:

Homework	15%
Project	20%
Four Exams	55%
Final Examination	10%

NOTES:

1. Homework will be sent electronically and will also be posted on blackboard (bb).

2. **Please do not copy homework from others** and if caught, both (or more) sets of homework will be given a grade of zero and may be subject to disciplinary action.
   Also remember the penalty involved for plagiarism. Very serious consequences may evolve in such a situation.

3. Questions will be asked from the students at random from the material already covered in the lectures. You must come prepared to the class for this type of discussion.

4. Absence from the class must be explained in writing (signed) otherwise it will be considered as unexcused absence. **Students will be dropped from the class after 4 unexcused absences**.

5. **The grades on homework and exams can only be discussed within one week after returning them in the class**. It is your responsibility for collecting these immediately after my handing it out to class. The days of absence are included in this one-week period.

6. Instructions on project details will be provided to you later.

DETAILS OF COURSE OUTLINE

CHAPTER 1 (Materials: Structure, Properties, and Performance)

1.1 Introduction
1.3 Structure of Materials
1.3.1 Crystal Structures
1.3.2 Metals
1.3.3 Ceramics
1.3.4 Glasses
1.3.5 Polymers
Chemical Structure
Types of Polymers
Thermosetting Polymers and Thermoplastics
Degree of Crystallinity
Molecular Weight and Distribution

CHAPTER 3 (Plasticity)

3.1 Introduction
3.2 Plastic Deformation in Tension
3.2.1 Tensile Curve Parameters
3.2.2 Necking
3.2.3 Strain Rate Effects
3.3 Plastic Deformation in Compression Testing
3.4 The Bauschinger Effect
3.5 Plastic Deformation of Polymers
3.5.1 Stress-Strain Curves
3.5.2 Glassy Polymers
3.5.3 Semicrystalline Polymers
3.5.4 Viscous Flow
3.5.5 Adiabatic Heating
3.6 Plastic Deformation of Glasses
3.6.1 Microscopic Deformation Mechanism
3.6.2 Temperature Dependence and Viscosity
3.8 Hardness
3.8.1 *Macroindentation Tests*
Brinell Hardness Tests
Rockwell Hardness Test
Vickers (or Diamond Pyramid) Hardness Tests
3.8.2 Microindentation Test
3.8.3 Nanoidentation
3.9 Formability: Important Parameters
3.9.1 Plastic Anisotropy

CHAPTER 4 (Imperfections: Point and Line Defects)

4.1 Introduction
4.2 Theoretical Shear Strength
4.3 Atomic or Electronic Point Defects
4.3.1 Equilibrium of Point Defects
4.3.2 Production of Point Defects
4.3.3 Effect of point Defects on Mechanical Properties
4.4 Line Defects
4.4.1 Experimental Observation of Dislocations

10.2 Solid Solution Strengthening
10.2.1 Elastic Interactions
10.2.1 Other Interactions

10.3 Mechanical Effects Associated With Solid Solutions
10.3.1 Well-Defined Yield Point in the Stress-Strain Curves
10.3.2 Plateau in the Stress-Strain Curve and Luders Band
10.3.3 Strain Aging
10.3.4 Serrated Stress-strain Curve
10.3.5 Snoek Effect
10.3.6 Blue Brittleness
10.4 Precipitation and Dispersion Hardening
10.5 Dislocation-Precipitation Interaction
The precipitate particles are impenetrable to the dislocations
The precipitate particles are penetrable to dislocations
10.6 Precipitation in Microalloyed Steels

CHAPTER 13 (Creep and Superplasticity)

13.1 Introduction
13.2 Correlation and Extrapolation Methods
13.3 Fundamental Mechanisms Responsible for Creep
13.4 Diffusion Creep
13.5 Dislocation Creep
13.6 Dislocation Glide
13.7 Grain Boundary Sliding
13.8 Deformation –Mechanism (Weertman-Ashby) Maps
13.9 Creep Introduced Fracture
13.10 Heat Resistant Materials
13.11 Creep in Polymers
13.13 Superplasticity

CHAPTER 14 (Fatigue)

14.1 Introduction
14.2 Fatigue Parameters and S-N Curves
14.3 Fatigue Strength or Fatigue Life
14.4 Effect of Mean Stress on Fatigue Life
14.5 Effects of Frequency
14.6 Cumulative Damage and Life Prediction
14.7 Mechanisms of Fatigue
14.7.1 Fatigue Crack Nucleation
14.7.2 Fatigue Crack Propagation
14.8 Linear Fracture Mechanics Applied to Fatigue
14.9 Hysteric Heating in Fatigue

CHAPTER 15 (Composite Materials)

15.1 Introduction
15.2 Types of Composites
15.3 Important Reinforcements and Matrix Materials
15.3.1 Microstructural Aspects and Importance of the Matrix
15.4 Interfaces in Composites
15.4.1 Crystallographic Nature of the Fiber/Matrix Interface
15.4.2 Interfacial Bonding in Composites