Mechanical Engineering 354, Mechanics of Materials Laboratory

Autumn 2002

Notebook: **Website**:Mechanics of Materials Laboratory, Michael Jenkins,[University of Washington]
Textbook: **Required:**Mechanical Behaviour of Materials, Norman Dowling,[Prentice Hall Pub][ISBN 0-13-905720-X]
Reference: Mechanics of Materials, Russel Hibbeler, [Prentice Hall Pub] (CEE 220 Text)
Notes: **Website:** Some Salient Aspects of ME354, Michael Jenkins, [University of Washington]

Lectures: TWF 9:30-10:20, MEB 238
Pre/Post Lab Recitation: M9:30-10:20 MEB238
Labs: M, T, W 14:30-17:20 MEB 127

Instructor: Prof. Michael Jenkins: 206-685-7061, jenkinsm@u.washington.edu OH: MWF 10:30 to 12:20, MEB 305
Course T.A: Michael Dahl; micdahl@u.washington.edu OH: TTh 13:30-14:30; MEB 127

Website: http://courses.washington.edu/mengr354/jenkins/index.html

Week	Event	Topic
Week 1	Lab: None	
30 Sept	Lecture (Text Chap 1,2, 3; Notes Chap 1)	Course Overview, Review Mechanics of Materials
01 Oct	Lecture	Lab. Procedure, Significant Figures, Accuracy/Precision
02 Oct	Lecture	Lab. Procedure, Significant Figures, Accuracy/Precision
04 Oct	Lecture	Statistical Analysis of Data, Stress/strain
Week 2	Lab: Strains, Deflections and Beams in Bending (Memo report)	
08 Oct	Lecture (Text: Chap 6, Notes: Chap 2,3)	Transformations, Mohr's Circle
09 Oct	Lecture	3-D and Principal Stresses, Special Cases
11 Oct	Lecture (Day before Columbus Day)	Beams in Bending: Fundamentals and Limitations
Week 3	Lab: Curved Beams (In-lab report)	
15 Oct	Lecture (Text Chap 6; Notes: Chap 4)	Curved Beams
16 Oct	Lecture	Composite Beams, Non symmetric Beams and Loading
18 Oct	Lecture	Mechanical Properties of Materials
Week 4	Lab: Mechanical Properties and Performance of Materials (Tension and Hardness) (Formal report)	
22 Oct	Lecture (Text Chap 4, 5; Notes: Chap 5)	Mechanical Testing and Test Machines
23 Oct	Lecture	Mechanical Tests (Properties, Performance, Standards)
25 Oct	Lecture	Mechanical Tests (Properties, Performance, Standards)
Week 5	Lab: Mechanical Properties and Performance of Materials (Torsion and Impact) (Formal report)	
29 Oct	Lecture (Text Chap 12,13; Notes Chap 5)	Plastic Deformation and Plasticity
30 Oct	Lecture (Day before Halloween)	Plastic Deformation and Plasticity
01 Nov	Lecture (All Hallows Day)	Midterm Exam
Week 6	Lab: Stress Concentrations and Fracture (In-lab report)	
05 Nov	Lecture (Text Chap 7, 8; Notes Chap 6, 7)	Failure Criterion, Stress Concentrations, LEFM
06 Nov	Lecture	Failure Criterion, Stress Concentrations, LEFM
08 Nov	Lecture	Failure Criterion, Stress Concentrations, LEFM
Week 7	Lab: Creep and Fatigue- Time Dependent Deformation and Failure (Memo report)	
12 Nov	Lecture (Day after Veteran's Day)	Time Dependent Behaviour, Long-term Predictions
13 Nov	Lecture (Text Chap 15; Notes Chap 8, 9)	Time Dependent Behaviour, Long-term Predictions
15 Nov	Lecture	Time Dependent Behaviour, Long-term Predictions
Week 8	Lab: Structural Evaluation (Measurements) (Formal report)	
19 Nov	Lecture (Text Chap 9, 10, 11, Notes Chap 8,9)	Cyclic Fatigue, S-N curves, LEFM and Fatigue Crack Growth
20 Nov	Lecture	Cyclic Fatigue, S-N curves, LEFM and Fatigue Crack Growth
22 Nov	Lecture	Cyclic Fatigue, S-N curves, LEFM and Fatigue Crack Growth
Week 9	Lab: Structural Evaluation (Analysis) (Formal report)	
26 Nov	Lecture (Notes Chap 11, 12)	Simple and Complex Structures
27 Nov	Lecture (day before T-day break)	Simple and Complex Structures
29 Nov	**Holiday**	**Thanksgiving Holiday**
Week 10	Lab: Compression and Buckling (In-lab report)	
03 Dec	Lecture (Notes Chap 10)	Compression, Yielding and Buckling
04 Dec	Lecture	Compression, Yielding and Buckling
06 Dec	Lecture (St. Nicholas Day)	Compression, Yielding and Buckling
Week 11	Lab: None	
09 Dec	Lecture	Other topics (indeterminate, etc.)
10 Dec	Lecture	Other topics (indeterminate, etc.)
11 Dec	Lecture (last day of instruction)	Overview, Review, Evaluation

Final Exam: Comprehensive; Tuesday, 17 December 2002, 8:30-10:20

Generally, lab reports are due by Friday of the week of the next lab period. Labs meet every week in MEB 127.

Grading: **65%** Laboratory Exercises, including reports, participation, etc. (Totals of Homework and In-class Projects are 1 Lab Report each) **+ 15%** Midterm Exam + **20%** Comprehensive Final

ME 354 Mechanics of Materials Laboratory

OVERVIEW

Prerequisites - MSE 170 "Intro to Materials Science"
- CE E 220 "Mechanics of Materials"

General Description: **Mechanics of Materials Laboratory (5 Credits)**

Study of the properties, behavior and performance of engineering materials including stress-strain relations, strength, deformation, fracture, creep, and cyclic fatigue. Introduction to experimental techniques common to structural engineering, interpretation of experimental data, comparison of measurements to numerical/analytical predictions, and formal, engineering report writing.

Each week: Three 1-hr lectures + One 1-hr pre/post lab recitation + One 3-hr laboratory

Course Goals:

To give students (generally junior standing) a basic understanding of the relationships between structures and components and the properties and performance of engineering materials which comprise them. Emphasis is placed on the engineering laboratory experience.

Course Outline:

Mechanical Fundamentals

- Review of mechanics and strength of materials
- Stress-strain relations, failure theories, bending and torsional relations
- Introduction to plasticity, fracture mechanics, fatigue, creep
- Types of joining and effects of discontinuities

Material Fundamentals

- Material classes: metals and alloys; ceramics and glasses; polymers; composites
- Atomic bonding; amorphous and crystalline microstructures
- Lattice defects; dislocations
- Strengthening mechanisms including fibre/particle/whisker reinforcement
- Fracture: theoretical vs. actual strengths
- Time dependent mechanisms: creep deformation and fatigue failures

Materials/Structural Testing

- Tension
- Compression
- Hardness
- Impact
- Torsion
- Stress Raisers
- Fracture mechanics
- Cyclic fatigue
- Creep /creep rupture
- Stresses, strains, forces and deflections

Suggested Additional Reading

Annual Book or ASTM Standards, American Society for Testing and Materials
Deformation and Fracture Mechanics of Engineering Materials, Richard Hertzberg
Elementary Engineering Fracture Mechanics, David Broek
Engineering Materials and Their Applications, Richard Flinn and Paul Trojan
Engineering Materials 1 and 2, Michael Ashby and David Jones
Fatigue of Materials, Subra Suresh
Introduction of Fracture Mechanics, Kare Hellan
Mechanical Behavior of Materials, Thomas Courtney
Mechanical Engineering Design, Joseph Shigley and Larry Mitchell
Mechanical Metallurgy George Dieter
Mechanics of Materials, Russel Hibbeler
Mechanics of Materials, David Roylance
Metal Fatigue in Engineering, H. Fuchs and R. Stephens
Stress, Strain, and Strength, Robert Juvinall

ABET Course Syllabus

Course: ME 354 Mechanics of Materials Laboratory **(required)**

Course Coordinator: Michael Jenkins **Interest Group** MMM

Catalog Description: Study of the properties and behavior of engineering materials, including stress-strain relations, strength, deformation, fracture, creep and cyclic fatigue. Introduction to experimental techniques common to structural engineering, interpretation of test data, comparison of measurements to numerical/analytical predictions, and formal engineering report writing. **(5 cr)**

Course Overview: ME 354 involves the application of fundamental mechanics of materials in "hands-on" laboratory exercises. The two pedagogical goals (1) "to do" the exercises, observing and appling the aspects of mechanics of materials either learned in previous course or introduced in ME354, and (2) "to say" in formal and informal laboratory reports how basic concepts were applied in laboratory exercises.

Course Prerequisites: MSE / ENGR 170 "Fundamentals of Mater. Science"
CE / ENGR 220 "Mechanics of Materials"

Textbook or other required material:

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Course Objectives: By the end of this course, the student will be able to:

1) List and explain applicable experimental methods for characterizing material and component behavior
2) Compare (and quantify differences) measured experimental results and calculated theoretical values.
3) Predict component behavior using experimental test results and engineering formulae
4) Analyze experimental data, theoretical models and their scalability to components
5) Analyze (deduce) the inherent variability of materials subjected to multiple modes of loading and apply the results to component behavior.
6) Formulate a solution path for analyzing an actual multi-component structure using experimental, theoretical, and numerical tools/methods.
7) Evaluate the limits of structures by extending the experimental measurements using theoretical and numerical methods

Topics Covered:

Mechanical Fundamentals
- Review of mechanics and strength of materials
- Stress-strain relations, failure theories, bending and torsional relations
- Introduction to plasticity, fracture mechanics, fatigue, creep
- Types of joining and effects of discontinuities

Material Fundamentals
- Material classes: metals&alloys; ceramics&glasses; polymers; composites
- Atomic bonding; amorphous and crystalline microstructures
- Lattice defects; dislocations
- Strengthening mechanisms including fiber/particle/whisker reinforcement
- Fracture: theoretical vs. actual strengths
- Time dependent mechanisms: creep deformation and fatigue failures

Materials/Structural Testing
- Tension -Compression-Hardness-Impact
- Torsion-Stress Raisers- Fracture mechanics
- Cyclic fatigue - Creep /creep rupture
- Stresses, strains, forces and deflections

Class/laboratory schedule: Each week: Three 1-hr lectures + One 1-hr recitation + One 3-hr lab

Contribution of Course to Professional Component: Satisfies preparation for engineering practice by incorporating experimental work, basic engineering science, engineering/professional standards, and technical communication

Relationship of Course to Program Objectives: Directly addresses the following Programmatic Outcomes:

1a. Background in mathematics, science and engineering principles
1b. Ability to apply this knowledge to the formulation and solution of Mechanical Engineering problems
2b. Ability to develop, conduct, and analyze experiments or tests that may aid in this design process
3. Understanding of the necessary professional abilities of a practicing engineer including ethical conduct, teamwork in the pursuit of a goal and effective communication.

Person Preparing this Syllabus: Michael Jenkins

Date of Preparation: 17 February 2000