Mechanics of Materials Lab

ME 354
University of Washington, Seattle — Winter Quarter 2011

Location:	MEB 238 (Lecture)	**Time:**	9:30-10:20am MTuW
	MEB 238 (Recitation)		9:30-10:20am F
	MEB 127 (Lab)		2:30-5:20pm TuWThF

Instructor: Nathan J. Sniadecki
MEB 318
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Office Hours:	NS:	3:30-4:20pm	M	MEB 318	or by appointment
		1:30-2:20pm	Th	MEB 318	or by appointment
	TAs:	available after labs	TuWThF	MEB 127	or by appointment

Website: `http://courses.washington.edu/nsniadec/ME354/W11`

GoPost: `https://catalysttools.washington.edu/gopost/board/nsniadec/19834`

Description: Properties and behavior of engineering materials including stress-strain relations, strength, deformation mechanisms, strength, deformation, fracture, creep, and cyclic fatigue. Introduces experimental techniques common to structural engineering, interpretation of experimental data, comparison of measurements to numerical/analytical predictions, and formal, engineering report writing. Lecture and laboratory.

Prerequisites: MSE 170 – Fundamentals of Material Science
CEE 220 – Introduction to Mechanics of Materials

Required Text:

[1] Dowling, N. E., 2007, *Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue*, *3rd edition*, Pearson/Prentice Hall, Upper Saddle Ridge, NJ (ISBN: 0131863126)

Recommended Texts:

[2] Callister, W. D., *Materials Science and Engineering: An Introduction*, John Wiley & Sons, New York, NY
[3] Hibbeler, R.C., *Mechanics of Materials,* Pearson/Prentice Hall, Upper Saddle Ridge, NJ
[4] Taylor, J.R., *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements*, University Science Books, Sausalito, CA
[5] Humphrey, J.D., Holmes, J.W, *Style and Ethics of Communication in Science and Engineering*, Morgan & Claypool, http://tiny.cc/hVdRi

Grading:

1)	Reports	55%	Formal Reports 45%, In-lab Report 10%
2)	Exams	35%	Midterm Exam (15%), Final Exam (20%)
3)	Homework	10%	
4)	Quizzes	+1%	Fundamentals of Engineering Questions

Course Policies:

Homework Policy: All assignments must be handed in on Tuesdays before class starts. Late homework will be accepted if and only if arrangements are made by Monday morning.

Lab Report Policy: Late lab reports will not be accepted. All reports are to be turned into the TA of your lab section. Reports are due after two weeks and are to be turned in at the start of the lab period. In-lab reports are due by the end of the lab period. Please cite any figures or material that you copied, reproduced, or rewrote in your own words in the figure legend.

Collaboration Policy: You may discuss lab reports and homework with your fellow students, and even collaborate on the solution, but you must list on the report or homework the name of the person(s) that collaborated with you on the effort. You may not copy someone else's reports, data, or figures.

Exam Policy: All exams must be completed on the specified date. Only under proven, extraordinary circumstances will a makeup exam be permitted. Engineering calculators and a one-page sheet of handwritten notes are permitted.

Classroom Policy: Please consider the learning mission of the course and refrain from activity that is disruptive during lectures or lab sessions.

Grading Policy: The instructional team pledges to return your homework within two week and your lab reports within three weeks.

I have a zero-tolerance for cheating or plagiarism. Please refer to UW's Student Conduct Code.
http://www.washington.edu/students/handbook/conduct.html

Course Outcomes and Assessment:

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

1. List and explain experimental methods for characterizing material and component behavior
2. Compare and quantify differences between 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. Deduce the response in 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

Contribution of Course to Professional Development:

The aim of the course is to prepare students for engineering practices by familiarizing them with mechanical testing systems, conducting experimental work, advancing their fundamental engineering knowledge, cultivating professional engineering standards, and developing their technical communication abilities.

Course Schedule:

ME 354		**MECHANICAL BEHAVIOR OF MATERIALS**		
Winter Quarter 2011				
Date		**Class Topics**	**Readings**	**Due**
Week 1	**Lab 1**	**Beam lab (report)**	strngage.pdf	
3-Jan	M	Course Overview, Review of Mechanics of Materials	Ch 1-3, Appendix A	
4-Jan	T	Mechanics: 3D Stress/Strain, Plane Stress, Transformation Eqns	Ch 6.1-2	
5-Jan	W	Mechanics: Principal Stresses, Mohr's Circle	Ch 6.1-2	
7-Jan	F	*Lab Recitation: Method of Joints, Unit Load Method*	structure.pdf	
Week 2	**Lab 2**	**Bike Lab (report)**		
10-Jan	M	Mechanics: 3D Principal Stresses, Stress Invariants	Ch 6.3-4	
11-Jan	T	Failure Criteria: Max Normal, Tresca	Ch 7.1-4	Hw#1
12-Jan	W	Failure Criteria: von Mises Stress	Ch 6.5, 7.5-6	
14-Jan	F	*Lab Recitation: Photoelasticity, Lab 1 Q&A*	photoelas.pdf	
Week 3	**Lab 3**	**Photoelasticity Lab (in-lab)**		**Lab 1**
17-Jan	M	*** No Class (MLK Day) ***		
18-Jan	T	Hooke's Law: 3D eqns, thermal expansion	Ch 5.3	Hw#2
19-Jan	W	Hooke's Law: Anisotropic Materials	Ch 5.4	
21-Jan	F	*Lab Recitation: Instron, Lab 2 Q&A*		
Week 4	**Lab 4**	**Tensile Test Lab (report)**		**Lab 2**
24-Jan	M	Tensile Testing: Anatomy of the Stress-Strain Curve	Ch 4.1-2, 4.6-9	
25-Jan	T	Tensile Testing: True Stress/Strain	Ch 4.3-5	Hw#3
26-Jan	W	Deformation Models: Elasticity, Plasticity, Creep	Ch 5.1-2, 12.1-2	
28-Jan	F	Deformation Models: Relaxation, Stress-Strain Curves	Ch 12.3	
Week 5		**No Lab**		
31-Jan	M	Plasticity: Full Plastic Yielding	Ch 13.1-2	
1-Feb	T	Plasticity: Residual Stress	Ch 13.3	Hw#4
2-Feb	W	*** Exam #1 ***	Ch 1-7	
4-Feb	F	*Lab Recitation: Plasticity in Torsion, Lab 4 Q&A*	Ch 4.9.3-4, 13.4	
Week 6	**Lab 5**	**Torsion lab (report)**		**Lab 4**
7-Feb	M	Fracture: Modes, Risers, Fracture Toughness	Ch 8.1-2	
8-Feb	T	Fracture: Appling fracture to design	Ch 8.4-5	Hw#5
9-Feb	W	Fracture: LEFM	Ch 8.3, 8.6-7	
11-Feb	F	*Lab Recitation: Fracture Toughness Testing, Lab 5 Q&A*	Ch 8.6-7	
Week 7	**Lab 6**	**Fracture Lab (in-lab)**		
14-Feb	M	Creep: Deformation Models	Ch 15.1, 15.6-7	
15-Feb	T	Creep: Physical mechanism (Arrhenius relation)	Ch 15.3	Hw#6
16-Feb	W	Creep: Time-Temperature Parameters (Sherby-Dorn, Larson-Miller)	Ch 15.4	
18-Feb	F	*Lab Recitation: Creep Testing, Lab 5 Q&A*	Ch 15.2	
Week 8	**Lab 7**	**Creep Lab (report)**		**Lab 5**
21-Feb	M	*** No Class (President's Day) ***		
22-Feb	T	Fatigue: Mechanisms	Ch 9.1-6	Hw#7
23-Feb	W	Fatigue: Life-estimates	Ch 9.7-9	
25-Feb	F	*Lab Recitation: Fatigue, Lab 7 Q&A*		
Week 9	**Lab 8**	**Fatigue Lab (in-lab)**		
28-Feb	M	Fatigue: Crack Growth	Ch 11	
1-Mar	T	Fatigue: Crack Growth	Ch 11	Hw#8
2-Mar	W	Buckling: Euler's Formula	*Ch 13.1-3	
4-Mar	F	*Lab Recitation: Buckling, Lab 7 Q&A*		
Week 10	**Lab 9**	**Buckling Lab (in-lab)**		**Lab 7**
7-Mar	M	Buckling: Eccentricity loads	*Ch 13.4	
8-Mar	T	Buckling: Inelastic Buckling	*Ch 13.5	Hw#9
9-Mar	W	Video: UWTV Building the Boeing 787		
11-Mar	F	Review		
Finals Week				
16-Mar	W	Final Exam, 8:30-10:30am, MEB 238		