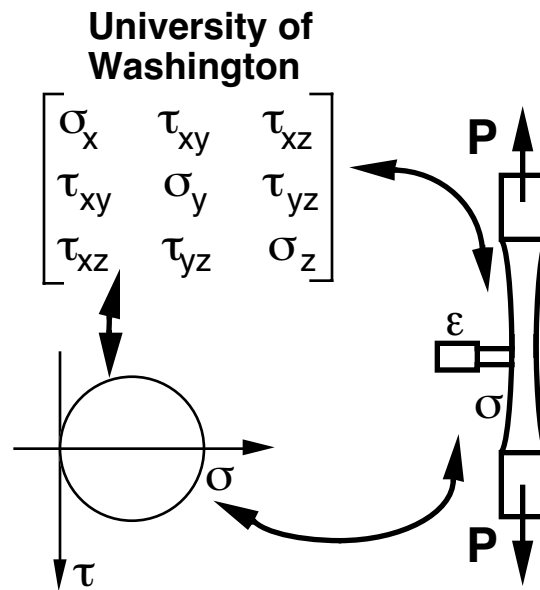


**ME 354**

**Mechanics of  
Materials  
Laboratory**



Course website: <http://swhite.me.washington.edu/~jenkinsm/me354/>

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Rev 2.0  
01 January 2001

Mechanical Engineering 354  
Mechanics of Materials Laboratory

TABLE OF CONTENTS

	<u>Topic</u>	<u>Page</u>
1.	Introduction ..... Laboratory Procedure Laboratory Report	1.1
2.	Stress/Strain/Constitutive Relations ..... Stress Strain Constitutive Relations	2.1
3.	Beams: Stress, Strain, Deflection (Lab Exercise) ..... Strain Stress: Normal and Shear Deflections	3.1
4.	Beams: Curved, Composite, Unsymmetrical Bending (Lab Exercise) ..... Curved Beams Unsymmetrical Bending Composite Beams	4.1
5.	Mechanical Properties and Performance of Materials (Tension, torsion, hardness, impact tests) (Lab Exercise) ..... Mechanical Testing Tension Hardness Torsion Impact Plasticity Relations	5.1
6.	Stress Concentration and Stress Raisers (Lab Exercise) ..... Stress Concentration Factors Effects of Stress Raisers Experimental Techniques	6.1
7.	Fracture and Effects of Cracks (Lab Exercise).....	7.1
8.	Time Dependent Behaviour: Creep Deformation (Lab Exercise).....	8.1
9.	Time Dependent Behaviour: Cyclic Fatigue (Lab Exercise).....	9.1

	<u>Topic</u>	<u>Page</u>
10.	Compression and Buckling of Columns (Lab Exercise).....	10.1
11.	Structures: Complex Stresses and Deflections (Lab Exercise) .....	11.1
	Failure Criteria	
	Combined Stresses	
	Types of Engineering Structures	
12.	Pressure Vessels: Combined Loading (Lab Exercise) .....	12.1
	Thin-Walled Pressure Vessels	
	Thick-Walled Pressure Vessels	
13.	References.....	R.1
	Appendix A: Lab Report Format .....	A.1
	Appendix B: Lab Exercise Handouts.....	B.1

# MECHANICS OF MATERIALS LABORATORY NOTES

## 1. INTRODUCTION

Mechanics of Materials is generally the name applied to a discipline in which the stress, strain and deflections of loaded structural elements are considered. This set of notes presents the laboratory aspects of this subject.

For nearly all design work it is necessary to know something of the elastic and, often, plastic properties of the material to be used. While these properties are often available from handbooks, sometimes particular properties of less common materials are needed, in which case the engineer must perform his own tests. The performance of these typical tests in this laboratory will give a better feeling for the significance of the various material properties and for the accuracy with which these quantities can be determined.

The various sections of these notes are concerned with review of the subject of mechanics of materials and related material properties including the laboratory application of these principles to a simple structures. In various exercises, the stresses, strains and deflections of a both simply-supported straight and curved beams are measured and compared to analytical predictions. In another exercise, selected mechanical properties and performance of representative engineering materials are measured using standardized test methods and quantitatively compared to handbook values. The effects of stress concentrations are the focus of another exercise in which photoelasticity is used to determine stress raisers for comparisons to values obtained from compendiums. Fracture mechanics and crack interactions are examined in a study of the load carrying reduction of cracks in components. Time-dependent behaviour is evaluated through measurement and analysis of creep deformation and cyclic fatigue failures. Structural instabilities such as column buckling are compared to material strength in assessing engineering failures. Complex structures are analyzed through experimental measurements and both simple and complex analytical methods to assess the implications of oversimplifications in engineering analysis.

### Laboratory Procedure

Mechanics of Materials Laboratory, ME 354, is intended to give an experimental understanding and verification of the coursework covered in Mechanics of Materials, CIVE 220 (formerly ENGR 220) and Introduction to Materials Science, MSE 170 (formerly ENGR 170). No one should be enrolled in this course who has not taken or is not currently taking MSE 170 and CIVE 220 or their equivalents.

Because of the nature of the laboratory experiments, it is necessary to conduct them as a class activity with students either observing or directly participating in the exercises. In some exercises, small by groups of students will conduct the experiment directly. In other exercises, the instructor will take the lead in operating the equipment with some students participating as assistants and others as observers and recorders. An instructor will always be available in the laboratory to introduce the exercise, describe the operation of the equipment, discuss the expected results and present the salient aspects of the analysis. Generally, students will be expected to work as teams when required but must complete written reports independently.

Some laboratory exercises require formal written reports. Other exercises require the completion of pre-formatted lab reports and their transmittal to the instructor in the form of a short memo report. Still other exercises require only the completion of pre-formatted write-ups without any additional writing. All lab reports, regardless of type, must be turned in to receive a passing course grade. Missing lab reports at the time of assignment of final grades will mean the assignment of a final grade of X for one quarter following the course, regardless of the quality of the rest of the coursework, until all reports are in. Failure to complete missing lab reports or to make other arrangements after one quarter has passed following completion of the course will result in the conversion of the X to a 0.0.

### Laboratory reports

Reports are the primary basis for the course grade. Examination grades and discussion participation are also considered in the final grade. Grades are important to the student for a relatively short time; report writing will be important to the student's total career.

The laboratory reports provide an opportunity for the student to sharpen writing skills and to increase the awareness of writing standards. Future employers will require standards and will judge your professional or technical ability in part on your reporting capabilities. Sherman (Sherman et al, 1975) has stated "It would be an overstatement, perhaps, to say that a career in a technical profession will be impossible if you cannot write effectively. It is no overstatement, however, to say that weakness in writing is a handicap that will weaken your qualifications for many desirable positions, and that skill in writing is an asset that can make your professional advancement faster and easier."

Technical writing involves style, neatness, grammar, usage of words, spelling, and format. Of these attributes, first five are generally applicable, whereas the sixth (i.e., format) is specific to the particular application. In the course, the format is non arbitrary and is detailed in the appendix.

Neatness: All written communications should be neat in their final form. Reports should be machine generated. Original data may be in pencil and is always included in the appendix of the report.

Grammar: Sentence structure, paragraph construction, and punctuation presumably have been learned prior to taking ME 354. Errors in grammar will be noted by the grader so that the student's writing skills will be improved.

Usage of Words: Misuse of words involves words and phrases that are problems for many writers. A few examples of such "pairs" are: affect-effect, among-between, because-for, fewer-less, like-as if, percent-portion, while-although, too-two, their-there.

Jargon is acceptable when properly used (i.e., not overused!). Specialized words are acceptable to a particular profession but should not be used to impress an "outsider." Debasing of the English language by the use of suffixes such as "ise" and "wise" is confusing and unnecessary. Colloquialisms or contractions should not be used in formal technical writing.

Style: The style of writing is determined by the potential reader. A report may be formal or informal, childish or mature, personal or impersonal, stilted or admirable, wordy or succinct. The formal laboratory report may be read by a teaching assistant or a professor, but it should be written for an engineering manager. Properly written laboratory reports may be used for reference material; well-written reports will enhance this value.

Do not copy portions of these notes word for word in your report. Statements in "your own words" will indicate understanding and descriptive conciseness ability. The use of future tense or telling "what you are going to do" does not belong in a report of what you did. Generally the tense of reports is such that anything in the report (e.g., tables, figures, section) are referred to in the present tense. Anything done to produce the results of the reports is in the past tense.

Traditionally, technical report writing has been conducted in the third person passive voice (e.g., "The tests were conducted"). The use of "I" imparts a personal tone to the report which is generally inappropriate. First person style emphasizes the writer's part in the experiment or test rather than the material or equipment used. "I" and "we" are sometimes used to reduce awkward or stilted language (such as using "one"). Such use should be kept to a minimum, particularly in the Summary.

Spelling: Spelling words properly is a problem for many students. Incorrectly spelled words, particularly simple words, indicate a juvenile approach to technical writing. To quote Sherman (Sherman et al, 1975), "Even a weak speller, if he keeps a list of the words that he misses, is usually surprised at its shortness.... He can often eliminate most of his errors by learning to spell no more than 40 or 50 words." Keep in mind that electronic spell checkers do not have any bearing on word choice. The wrong word correctly spelled is still the wrong word.

Words frequently misspelled in this course include: yield, specimen, temperature, Riehle, recommend, omission — to name just a few. The use of a word guide is strongly urged for those students with a spelling problem.

Grading: For formal lab reports, the weighting for grades of the various sections of the report are as follows for all exercises. Typically, grading is based on 50% communication, 50% technical correctness.

A formal report which contains misspelled words, bad grammar, poor formatting, etc. will not receive a perfect grade. Deductions from grades for these types of errors will depend upon flagrancy and frequency.

**Appeal:** Generally, there will be a one week period after the graded laboratory report is returned to ask questions and appeal the awarded grade. Appeals should be made, first to the grader and only if necessary to the course instructor. The course instructor is the final adjudicator in such matters. All lab grades will be assumed final after the one week period.

**Due Date:** All formal, written lab reports are due approximately one week after completion of the lab work (i.e. at the end of the week when the next lab is performed). Memo reports are due at the end of the week in which the lab work is performed. Informal, preformatted reports are generally due at the end of the lab period in which they are performed.

**Late labs:** Lab reports turned in late (after Friday of the week in which the reports are due for formal written lab reports and after the day on which the lab exercise was performed) will have the final score reduced by **10%** for each week the report is late to a maximum of **50%** reduction.

The preformatted lab report is not meant to be a casual report. It should be prepared with the same care, neatness, attention to spelling and grammar, etc., as the formal report even though it is intended only to be hand written. All questions should be answered and results of all calculation shown. A report which contains misspelled words will not receive a perfect grade. Deductions from grades for spelling errors will depend upon flagrancy and frequency.

**Late homework:** Homework turned in late will have the final score reduced by the following schedule: 0% if turned in on the due date; 50% if turned in after the due date but before the solution is posted; 100% if turned in after the solution is posted.

**All lab reports must be turned in to receive a passing course grade. Missing lab reports at the time of assignment of final grades will mean the assignment of a final grade of X for one quarter following the course, regardless of the quality of the rest of the coursework, until all reports are in. Failure to complete missing lab reports or to make other arrangements after one quarter has passed following completion of the course will result in the conversion of the X to a 0.0.**

**ME 354, MECHANICS OF MATERIALS LABORATORY  
LABORATORY REPORT FORMAT AND GRADING SHEET  
for Most Formal Written Reports**

AREA OF REPORT	POINTS	
	POSSIBLE	AWARDED
<b>TITLE PAGE</b> List the title of laboratory experiment or test, name of report author, lab section, name of the teaching assistant, and date of the lab. Include an "executive summary" which provides the results and conclusion of the lab "in a nutshell."	<b>5</b>	
<b>OBJECTIVES</b> Provide a short statement of the goals of the laboratory experiment or test.	<b>10</b>	
<b>TEST DESCRIPTION</b> Describe the type of experiment or test, the material tested, and the apparatus used in the experiment or test (include an illustration of the experimental set up).	<b>10</b>	
<b>RESULTS</b> Present calculated results, graphs, tables, and final equations in a coherent and understandable manner. Each graph, table, etc. must have a figure caption or table heading and must be referred to the text in support of the presented results. Place raw data (such as strip chart plots and data sheets) in the appendix.	<b>30</b>	
<b>DISCUSSION / CONCLUSIONS</b> Discuss the results of the experiment or test through interpretation of data , <u>error analysis</u> (i.e. include all sources and discuss relative magnitude, probability, how ([quantitative $\pm$ ] the error would affect the experimental results), etc. (Note: Answer the question - Did I get the results I expected? If not, why not?) If obtaining material properties, compare your experimental results to published data.	<b>30</b>	
<b>APPENDIX</b> Include equations, calculations, or work which are secondary to the report including actual (or copies of) actual data sheets, strip chart plots, etc.	<b>15</b>	
<b>TOTAL SCORE</b>	<b>100</b>	
<b>COMMENTS</b>		



The total number of points for each lab report depends on whether the report is a formal or informal report as well as its complexity. For each exercise, the lab exercise, time to complete the lab, type of report and total points are shown in the following.

STRAINS, DEFLECTIONS & BEAM BENDING	1 wk	Memo report	75 pts
STRESSES IN STRAIGHT & CURVED BEAMS	1 wk	In lab report	50 pts
MECHANICAL PROPERTIES & PERFORMANCE: OF MATERIALS: Tension and Hardness, total	1 wk	Formal report	100 pts
MECHANICAL PROPERTIES & PERFORMANCE: OF MATERIALS: Torsion and Impact,	1 wk	Formal report	100 pts
STRESS CONCENTRATIONS	1 wk	In lab report	50 pts
FRACTURE	total	In lab report	50 pts
COMPRESSION & BUCKLING	1 wk	In lab report	50 pts
FATIGUE	1 wk	In lab report	50 pts
CREEP	total	Memo report	75 pts
STRUCTURES	2 wk	Formal report	100 pts
PRESSURE VESSELS & COMBINED LOADING	1 wk	In lab report	50 pts

Total of all homework counts as one-100 pt lab

Total of all in-class projects will counts as one-100 pt lab

Physical Requirements: Formal and memo reports must be machine-printed (typewritten or computer printed) [generally handwritten reports are not acceptable]. Good quality printouts on high quality paper must be used (printer draft mode is not acceptable). Plots and tables must be computer-generated or machine-printed (not just photo copied) at a minimum. DO NOT USE A POLYMER, CARDBOARD, OR OTHER TYPE OF COVER.

Original work is required especially for figures although some latitude is provided if course materials are used IF credit is given.