

# Slow and Steady: Teaching ME211 over Two Semesters

M. D. Thouless – Department of Mechanical Engineering  
College of Engineering

## Abstract

ME211 "Introduction to Solid Mechanics" is a core / required class in Mechanical Engineering. The class is fast-paced, with a fundamental new concept being introduced every other lecture or so, and no time for reflection and absorption.

In this experiment, ME211 was taught over F-15 and W-16 as two linked two-credit classes. The format, content and exams were identical to the regular section, but at half the pace.

The approach was assessed by a direct comparison of exam results with a control section of the regular version of ME211 taught in W-16. While the performance in the first two mid-terms mirrored the GPA distribution for both classes, the performance of the experimental section was significantly superior to that of the regular section.

## Methods

The student population for the experimental section was self-selected. 25 students enrolled in the first semester, but one student changed majors after F-15, and did not enroll in the second section. The demographics of the students in the experimental section were strikingly different from the usual enrollment in a Mechanical Engineering class, with 37.5% females, and 29.2% being males of apparently non-European descent.

The homeworks were similar for both sections, although not identical because of the timing. The first two mid-terms were identical for both sections, although neither section knew this. Solutions were not published before the regular class had taken the exams, but some numbers were changed to ensure integrity. Both sections took an identical final on the same day (April 20, 2016), and these exams were marked together as a unified group.

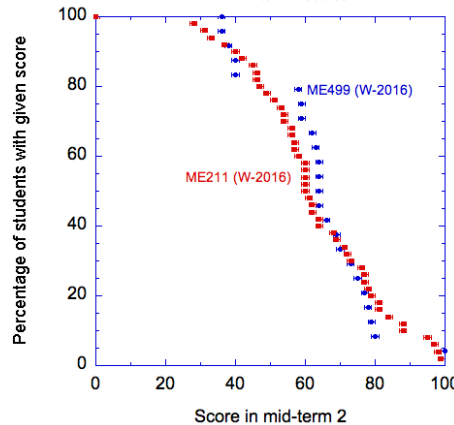
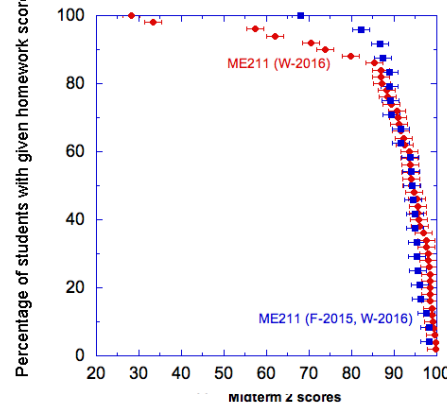
The regular section of ME211 consists of three faculty-taught lectures plus one GSI-led discussion section per week. The experimental section consisted of three faculty-taught lectures plus one GSI-led discussion section every two weeks.

Each semester of the experimental section required students to enroll in a 2-credit class ME499-098. At the end of F-15, one mid-term and half the homeworks had been completed, and a "Y" grade was assigned. At the end of W-16, the "Y" grade was replaced by a letter grade based on the overall performance during the two semester.

ME 211 INTRODUCTION TO SOLID MECHANICS  
COURSE OUTLINE – Winter 2016

Class	Date	Topic	Reading	Homework
1	W 1/18	Introduction	Chapter 1	None
2	F 1/21	Stress	Chapter 2, suppl. A	
3	F 1/21	Vector problems and moments	13.1-13.2, suppl. B	
4	W 1/25	Equilibrium (2D)	14.1-14.4, suppl. C	HW 1
5	F 1/28	Equilibrium (3D)	14.5, 14.6, suppl. D	
6	M 1/28	MILK Day		
7	F 1/29	Two force member structures	14.7-14.8, suppl. E	HW 2
8	W 1/31	More general structures	15.1, suppl. F	
9	W 1/31	Centroids and distributed loading	16.1, 16.3, suppl. G	HW 3
10	F 2/01	Internal loading	17.1-17.2	
11	M 2/01	Shear force and bending moment diagrams	17.11-17.12, suppl. H	
12	W 2/04	Shear force and bending moment diagrams	17.13-17.17	HW 4
13	F 2/07	Concept of stress	17.17-17.17	
14	W 2/08	Internal loading	Chapter 9, suppl. I	HW 5
15	M 2/08	MILK Day – Lectures 1-24		
16	W 2/11	Axial loading (determinate problems)	19.1-19.3, suppl. K	
17	F 2/15	Indeterminate problems and thermal stress	19.4-19.6, suppl. L	HW 6
18	M 2/15	Review of cylinders	101.1-101.6, suppl. M	
19	W 2/15	Torsion examples, including indeterminate problems	101.7	HW 7
20	F 2/22	Thin-walled		
21	M 2/22	Spring Break		
22	W 2/24	Spring Break		
23	F 2/26	Internal loading	111.1, 111.4	
24	W 2/29	Shear stress and shear flow	16.1, 16.3, 16.6, suppl. N	HW 8
25	F 3/01	Bending stress (composite)	111.1	
26	M 3/01	Passive results	111.1	
27	F 3/04	Review of Lectures 13-24		
28	M 3/04	MILK Day – Lectures 13-24		
29	W 3/07	Combined loading	114.1-114.3	HW 9
30	F 3/07	Stress transformation equations	114.1-114.3	
31	M 3/07	MILK Day		
32	W 3/09	Mohr's circle and 3-D stress, shear stress	114.4, 114.5, suppl. P	
33	F 3/12	Strain transformation, strain gage rosettes	114.6-114.9	HW 10
34	W 3/16	Mechanical stress	114.1-114.3	
35	M 3/16	Relations between elastic constants	114.1, suppl. Q	
36	W 3/16	Discussion		
37	F 3/20	Discussion		
38	M 3/20	Bending deflections (continuous loading)	116.1, 116.2, suppl. R	HW 11
39	W 3/20	Discussion		
40	F 3/23	Discussion		
41	M 3/23	Discussion		
42	W 3/23	Review of F-15 content		
43	F 3/27	Review of W-16 content		
44	M 3/27	Final Exam		

N.B. There are also Discussion sections scheduled for every Wednesday. The final exam is on April 20.



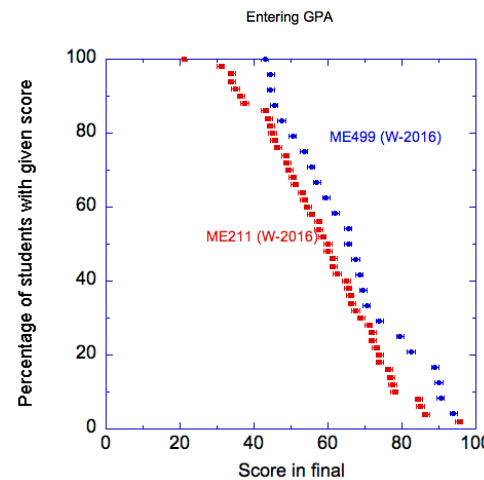
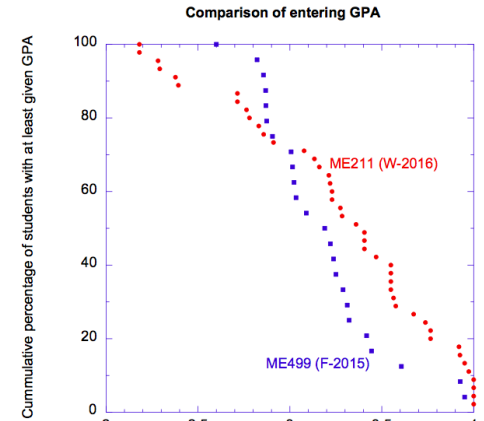
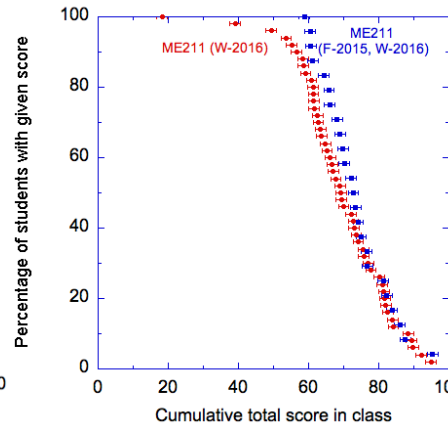
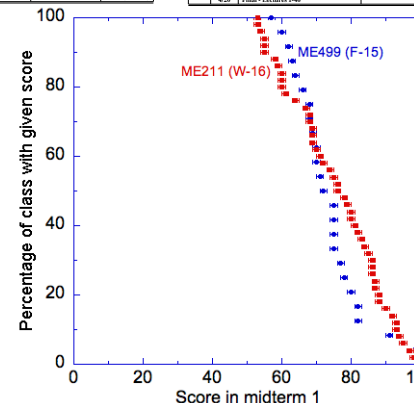
## Results

ME 499-098 INTRODUCTION TO SOLID MECHANICS (PART 1)  
COURSE OUTLINE – Fall 2015

Class	Date	Topic	Reading	Homework
1	W 9/14	Introduction	Chapter 1	
2	M 9/14	Discussion	Chapter 2, suppl. A	
3	W 9/14	Stress: products and moments	13.1-13.6, suppl. B	
4	F 9/21	Discussion		
5	W 9/23	Equilibrium (2D)	14.1-14.4, suppl. C	
6	M 9/29	Equilibrium (3D)	14.5-14.6, suppl. D	HW 1 (F-02/5)
7	W 9/30	Friction	14.7-14.8, suppl. E	
8	M 10/05	Discussion		
9	W 10/05	Two-force member structures	15.1-15.4	HW 2 (F-10/9)
10	M 10/12	More general structures	15.5, suppl. F	
11	W 10/12	Centroids and distributed loading	16.1, 16.3, suppl. G	
12	M 10/19	Discussion		
13	W 10/19	Internal loading	17.1, 17.2	HW 3 (F-10/23)
14	M 10/26	Shear force and bending moment diagrams	17.11, 17.12, suppl. H	
15	W 10/26	Discussion		
16	F 11/02	Concept of stress	17.17-17.17	HW 4 (F-11/6)
17	M 11/02	Internal loading		
18	W 11/02	Review of Lectures 1-12		
19	M 11/09	MILK Day – Lectures 1-12		
20	W 11/09	Concept of stress	17.17-17.17, suppl. I	
21	F 11/16	Internal loading	Chapter 9, suppl. J	
22	M 11/16	Discussion		
23	W 11/16	Axial loading (determinate problems)	19.1-19.3, suppl. K	
24	F 11/23	Indeterminate problems and thermal stress	19.4-19.6, suppl. L	HW 5 (F-12/4)
25	M 11/23	Discussion		
26	W 11/23	Torsion examples, including indeterminate problems	101.1-101.6, suppl. M	
27	F 11/30	Thin-walled	101.7	HW 6 (F-12/14)

ME 499-098 INTRODUCTION TO SOLID MECHANICS (PART 2)  
COURSE OUTLINE – Winter 2016

Class	Date	Topic	Reading	Homework
1	F 1/18	Review of previous		
2	M 1/18	Discussion (torsion)		111.3, 111.4
3	W 1/18	Bending stress		
4	M 1/25	MILK Day		
5	W 1/25	Centroids and moments	16.2, 16.4-16.6, suppl. N	HW 7 (F-1/22)
6	M 2/01	Discussion		
7	W 2/01	Stress transformation equations	114.1-114.3	HW 8 (F-2/26)
8	M 2/01	MILK Day – Lectures 13-24		
9	W 2/01	Discussion		
10	M 2/08	Combined loading	114.1	
11	W 2/08	Examples of combined loading		
12	F 2/08	Discussion		
13	W 2/08	Stress transformation equations	114.1-114.3	HW 9 (F-2/26)
14	M 2/08	Spring Break		
15	W 2/08	Spring Break		
16	F 2/08	Mohr's circle and 3-D stress, shear stress	114.4, 114.5, suppl. P	
17	W 2/08	Strain transformation, strain gage rosettes	114.6-114.9	HW 10 (F-3/18)
18	M 2/08	Mechanical stress	114.1-114.3	
19	W 2/08	Relations between elastic constants	114.1, suppl. Q	
20	F 2/08	Discussion		
21	M 2/08	Bending deflections (continuous loading)	116.1, 116.2, suppl. R	HW 11 (F-4/1)
22	W 2/08	Discussion		
23	F 2/08	Discussion		
24	M 2/08	Discussion		
25	W 2/08	Review of F-15 content		
26	F 2/08	Review of W-16 content		
27	M 2/08	Final Exam		



## Acknowledgements

The Investigating Student Learning (ISL) Program was funded by the University of Michigan Office of the Provost, the College of Engineering, and the Center for Research on Learning and Teaching.