CIVE 4300/5300 Advanced Mechanics of Materials

Fall Semester 2006 MW 2 – 3:15 PL 3070

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Catalog Course Description

Introduction to theory of elasticity, plane-stress and plane-strain problems, engineering beam theory, beam on elastic foundation, strain energy, curved flexural members, unsymmetrical bending, torsion, geometric nonlinearity, and axisymmetrically loaded members.

Prerequisites

Engineering Mechanics of Deformable Bodies (CIVE 1160), Differential Equations (MATH 3860).

Expanded Course Description

The first seven weeks of the course establish the basis for solution of classical advanced strength of materials problems. Stress, strain, constitutive relationships, yield criteria, and energy methods are covered. This encompasses a review of the basic strength of materials course as well as new material. The next six weeks of the course covers classical topics in advanced strength of materials: torsion of non-circular and open sections, nonsymmetrical bending of straight beams, shear center, bending of curved beams. The last time few weeks of the course are used to cover topics of interest, such as, an introduction to geometrically nonlinear problems, and elastic and inelastic stability.

Role in a Sequence of Courses

Builds on the initial strength of materials course to lay the foundation for more advanced courses. It provides the necessary background for elasticity, plasticity, and continuum mechanics courses. Provides a more sophisticated background for dealing with industrial structural design problems that are not routine.

Goals

At the end of this course, you should be able use the appropriate failure criteria for yield of brittle and ductile materials, be able to comfortably handle combined stress problems, be able to determine the stress and deformation of non-circular and hollow bars in torsion, and be able to determine the stresses in nonsymmetrical straight beams and curved beams.

Text

Boresi, A.P and R.J. Schmidt, Advanced Mechanics of Materials, Sixth Edition, Wiley, 2003, ISBN 0-471-43881-2.

Grading:

Homework	10%
2 Midterms	50%
Final	40%
	100%

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References:

Bickford, W.B., Advanced Mechanics of Materials, Addison-Wesley, 1998. General style is easier to follow than our text. Some sections of this book, particularly the section on plates, are very clear. This text includes many useful figures.

Boresi, A.P. and Chong, K.P., Elasticity in Engineering Mechanics, the first five chapters of our text are basically a condensation of this book. So additional explanation and proofs are in this text. (UT call number TA 405 .B67 1987). A second edition of this book is also available.

Budynas, R.G., Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw-Hill, 1999.

Cook, R.D., Advanced Mechanics of Materials, Macmillan, 1985 (TA405.C843 1985)

Fertis, D.G., Advanced Mechanics of Structures, Marcel Dekker, 1996.

Popov, E.P., Engineering Mechanics of Solids, Prentice Hall 1990. The late Prof. Popov is the clearest and best writer on mechanics I have ever seen. I particularly recommend this book to undergraduates if they want supplemental reading.

Timoshenko, S.P., As I Remember. His auto biography.

Timoshenko, S.P., History of Strength of Materials.

Timoshenko, S.P., Theory of Elasticity. An introductory book on the theory of elasticity might occasionally be useful. The clearest (although it is now a bit dated) is this classic republished by McGraw-Hill.

Ugural, A.C. and S.K. Fenster, Advanced Strength and Applied Elasticity, 3rd edition, Prentice Hall, 1995. (UT Library has the 1987 edition, call number TA405.U42 1987)

Vincenti, Walter G., What Engineers Know and How They Know It: Analytical Studies from Aeronautical History (Johns Hopkins Studies in the History of Technology)

Caveat to MIME undergraduates

The historically MIME has referred to this course as a design course. It is a misnomer to call this class a design course. It is an advanced mechanics of materials class.

As a designer of Civil and Mechanical structural systems, I feel strongly that the topics covered in this course are essential for anyone whose goal is to be competent in any phase of structural mechanics, including design. However, the focus is on the analysis of complex elements of structural systems rather than the conceptual development of a structural artifact that constitutes design.

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Fall Semester 2006

Course Outline
September 25, 2006 Rev. 0

Week	Period	Date	Subject	Reading Assignment	Problem Assignment
1	1	Aug. 21	Overview Tension Test	1.1-1.4	-------
1	2	Aug. 23	Classification of Materials Plastic Strain, Failure and Design Limits Stresses Stresses on arbitrary planes	1.3-1.5 2.1-2.2 2.3	1.11,21,22,25
2	3	Aug. 28	Principal Stresses, Stress Invariants, Principal Directions, Plane Stress	2.4	2.3,7,11,15
2	4	Aug. 30	Differential equations of equilibrium (motion)	2.4	2.25,27,31
3	5	Sept. 6	Strain	2.5	
4	6	Sept. 11	Strain-displacement relations, Compatibility, Strain gages and rosettes Stress-strain relations Generalized Hooke's Law of Linear elasticity Strains due to temperature change Hooke's law for orthotropic material	2.6-2.8 Ch. 3	2.34,35,37,38,39,40 3.2,3,4,5,6
	7	Sept. 13	Inelastic Material Behavior Types of Material Response	4.1-4.3	
5	8	Sept. 18	Yield criteria	4.4	4.4,7,10,17
	9	Sept. 20	Yield criteria (con't) Yield load vs. fully plastic load Effect of hydrostatic stresses on yield		4.18,21,24,27,29,30
6	10	Sept. 25	Energy Methods, deflection, examples	5.1	5.4, 5.14 (5.14 modified for undergraduates, text answer for 5.14 is wrong)
	11	Sept. 27	Energy Methods (con't)		
7	12	Oct. 2	Discussion		
	13	Oct. 4	Midterm		

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Week	Period	Date	Subject	Reading Assignment	Problem Assignment
8	14	Oct. 9	Classical topics in mech of materials Torsion of bars with circular cross-sections	Ch.6	6.2,3,4,7
	15	Oct. 11	Torsion of bars with circular cross-sections (con't) Torsion of bars with non-circular cross-sections		6.9,12,13
9	16	Oct. 16	Review of torsion Soap film analogy		6.16
	17	Oct. 18	Narrow rectangular cross-section Hollow thin wall torsion members		6.18,22,26,28,29, 30
10	18	Oct. 23	Torsion of I-beams restrained for warping	Ch. 6	6.31,.32
	19	Oct. 25	Nonsymmetric bending of straight beams	Ch. 7	7.1, 3, 6, 8 (I_y=403,000mm^4)
11	20	Oct. 30	Nonsymmetric bending of straight beams		7.12, 13, 27, 28, 33
	21	Nov. 1	Shear center for thin-walled beams (In problem 8.10: 80.77 should be 80.172; 9.62 should be 8.621; θ=-0.399; e_x=42.395; and e_y=137.99	Ch. 8	8.3, 8, 10, 22
12	22	Nov. 6	Bending of Curved Beams	Ch. 9.1- 9.5	9.4, 5
	23	Nov. 8	Bending of curved beams		9. 12
13	24	Nov. 13	Arbitrary symmetric cross-sections. Corrections for beams with thin flanges		9.15, 17
	25	Nov. 15	Discussion		
14	26	Nov. 20	Midterm		
	27	Nov. 22	Thanksgiving (No Class)		
15	28	Nov. 27	Geometric Nonlinearity	Handout reading and assignments	
	29	Nov. 29	Geometric Nonlinearity		
16	30	Dec. 4	Review of stiffness Solution to Example 12-1 in the text is incorrect. See my notes.		
	31	Dec. 6	Course Summary		

<u>Final Exam</u>
Friday Dec. 18 2:45-4:45

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Fall Semester 2006

Course Outline
September 25, 2006 Rev. 0

Please Note:

1. Homework will be due at the end of the week of assignment.
2. Homework should be on engineering paper, on one side of the page with the answers highlighted.
3. Credit for late homework is reduced by 10% for each class period it is late.
4. The midterms and the final exam are closed book and closed notes.
5. Academic dishonesty. You are encouraged to work together on the homework, but what you submit should be substantially your own work. The exams are strictly individual with no assistance to be given or received.

CIVE 5300 Advanced Mechanics of Materials Fall Semester 2008

Course Outline September 18, 2006

Week	Class	Date	Subject	Reading Assignment	Problem Assignment
Broadening and deepening the concepts introduced in strength of materials					
1	1	M Aug. 21	Overview Review of basic axial, torsion and bending stress, deflection and constituent relationships. Note: If the basic relationship and the geometry of deformation for them are not something you easily recall, review the basic relationships in any introductory text. The development will be well-paced and the graphics easy to follow.	1.1-1.4 See note under subject heading	-------
	2	W Aug. 23	Tension Test Classification of Materials Plastic Strain, Failure and Design Limits Stresses Stresses on arbitrary planes	1.3-1.4 2.1-2.2 2.3	1.11,14, 16, 21,22,23, 25, 31 (Word problems should be answered in 25 words or less)
2	3	M Aug. 28	Principal Stresses, Stress Invariants, Principal Directions	2.4	2.3, 7, 11(Grad only), 12
	4	W Aug. 30	Stress Transformations, Plane Stress	2.4	2.25, 27, 31,
3	----	M Sept. 4	Labor Day		
	5	W Sept. 6	Differential equations of equilibrium (motion) Strain, Strain-displacement relations,	2.5-2.7	2.44, 53,56, 57, 63, 64, small displacement problem
4	6	M Sept. 11	Compatibility, strain gages and rosettes Hooke's law for orthotropic material	2.8-2.9	
	7	W Sept. 13	Stress-strain relations Generalized Hooke's Law of Linear elasticity Strains due to temperature change	Ch. 3	3.2, 3, 4, 10, 11, Grad students also do 3.20.
5	8	M Sept. 18	Inelastic Material Behavior Types of Material Response Yield criteria	4.1-4.4	4.4, 7, 10, 11, 17
	9	W Sept. 20	Yield criteria (con't) Yield load vs. fully plastic load Effect of hydrostatic stresses on yield	4.5.1-2, 4.6	4.18, 21, 27, 29, 30, 36
6	10	M Sept. 25	Energy Methods, deflection, examples	5.1	5.4, 5.14 (5.14 modified for undergraduates, text answer for 5.14 is wrong)
	11	W Sept. 27	Energy Methods (con't)		
7	12	M Oct. 2	Discussion		
	13	W Oct. 4	Midterm		

CIVE 5300 Advanced Mechanics of Materials Fall Semester 2008

Course Outline September 18, 2006

Week	Period	Date	Subject	Reading Assignment	Problem Assignment
Classical topics in mechanics of materials					
8	14	M Oct. 9	Torsion of bars with circular cross-sections	Ch.6	6.2,3,4,7
	15	W Oct. 11	Torsion of bars with circular cross-sections (con't) Torsion of bars with non-circular cross-sections		6.9,12,13
9	----	M Oct. 16	Fall Break		
	16	W Oct. 18	Review of torsion Soap film analogy		6.16
10	17	M Oct. 23	Narrow rectangular cross-section Hollow thin wall torsion members		6.18,22,26,28,29, 30
	18	W Oct. 25	Torsion of I-beams restrained for warping	Ch. 6	6.31,.32
11	19	M Oct. 30	Nonsymmetric bending of straight beams	Ch. 7	7.1, 3, 6, 8 (I_y=403,000mm^4)
	20	W Nov. 1	Nonsymmetric bending of straight beams		7.12, 13, 27, 28, 33
12	21	M Nov. 6	Shear center for thin-walled beams (In problem 8.10: 80.77 should be 80.172; 9.62 should be 8.621; θ=-0.399; e_x=42.395; and e_y=137.99	Ch. 8	8.3, 8, 10, 22
	22	W Nov. 8	Bending of Curved Beams	Ch. 9.1- 9.5	9.4, 5
13	23	M Nov. 13	Bending of curved beams		9. 12
	24	W Nov. 15	Arbitrary symmetric cross-sections. Corrections for beams with thin flanges Discussion		9.15, 17
14	25	M Nov. 20	Midterm		
	26	W Nov. 22	Thanksgiving (No Class)		
Special topics					
15	27	Nov. 27	Special topic: Geometric Nonlinearity	Handout reading and assignments	
	28	Nov. 29	Special topic: Geometric Nonlinearity		
16	29	Dec. 4	Special topic: Review of stiffness Solution to Example 12-1 in the text is incorrect. See my notes.		
	30	Dec. 6	Course Summary		

Final Exam

Friday Dec. 14 12:30-2:30

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