AE 323 – APPLIED AEROSPACE STRUCTURES
Spring 2017

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Class Hours: Monday, Wednesday, Friday 9:00 am – 9:50 am, 124 Burrill Hall.

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Office Hours: **JL:** Monday, Wednesday 2:30 pm –4:00 pm, 310 Talbot Lab
RW: Tuesday, Thursday 4:00 pm – 6:00 pm, 225A Talbot Lab

Course Website: UIUC Compass 2g
Homework problems and solutions, the powerpoint slides used in class, and exam solutions will be posted here.

Recommended Textbook: Analysis of Aircraft Structures
Bruce K. Donaldson, Cambridge University Press, 2008
Print ISBN: 978-0-521-86583-8
Available online via UIUC Library
(There is also a 1993 edition from McGraw-Hill)

Exams: Two 50 minute midterm in-class exams (scheduled around weeks 8 and 13) and a final exam (7:00-10:00 p.m., Friday, May 5) will be held. All exams will be **closed book and closed notes** and the material covered in each exam is **cumulative** from the beginning of the semester. An equation sheet will be provided in each exam and **no calculators will be allowed**, unless otherwise noted.

Homework: Graded homework will be assigned roughly once a week. Although the homework will be graded (see below), the homework exercises should mainly be viewed as a learning tool to help you understand the material. It is impossible to master the material in the course without being in a position to solve a large proportion of these problems. In that sense, your success in the course will depend highly upon your completing these exercises. Your chances of success in the exams will increase drastically if you do the homework on a regular basis. If you feel you need additional practice beyond the exercises handed out, you should try to solve additional problems that can be found in various textbooks. Solutions to the exercises will be posted on the web after the homework is handed in. These solutions are also a learning tool and you should refer to them after having attempted the relevant exercises.

Grading:	Homework:	10%
	Midterm exam #1: (to be held **tentatively** on Friday March 10, 2017)	20%
	Midterm exam #2: (to be held **tentatively** on Monday April 17, 2017)	20%
	Final exam: (to be held on Friday, May 5 2017)	50%

Final grades will be allocated using the above percentages. A plus/minus scale will be used, although there is no grade curving.

Objectives: This course is designed to introduce students to the fundamental concepts of engineering theory of bending, torsion and extension of aircraft structures and to allow students to solve Boundary Value Problems of such structures subjected to a variety of boundary conditions. The specific objectives of this course are for the students to:

(a) be able to solve for stress, strain and displacement fields in beam bending problems,
(b) be able to solve thick and thin walled, single and multi-cell torsion problems,
(c) obtain an introduction into the field of aeroelasticity,
(d) understand the use of energy methods and their equivalence with equilibrium methods,
(e) become familiar with elastic column instability (buckling) problems.

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1. FUNDAMENTAL CONCEPTS OF ELASTICITY

1.1. Stresses
1.1.1. Definition of traction and stress
1.1.2. Equations of equilibrium
1.1.3. Principal stresses and directions
1.2. Strains
1.2.1. Normal and shear strains
1.2.2. Compatibility
1.3. Material response
1.3.1. Uniaxial material behavior
1.3.2. Generalized Hooke's law

2. STRENGTH OF MATERIALS ANALYSIS OF STRAIGHT, LONG BEAMS

2.1. Beam bending/extension
2.1.1. Bending and extensional stresses
Conventions for internal forces and moments
Definitions of resultant forces and moments
Bending moment and shear force diagrams
Basic assumptions of Euler-Bernouilli beam theory
Displacements and strains in the beam
Bending and extensional stresses
Accuracy of beam stress equation
2.1.2. Beam deflections in bending/extension
Equilibrium in terms of force and moment resultants
Equilibrium in terms of deflections
Boundary conditions
2.1.3. Elastic boundary conditions
2.1.4. Partial span and concentrated loads
Dirac delta function
Step function

2. STRENGTH OF MATERIALS ANALYSIS OF STRAIGHT, LONG BEAMS (cont.)

2.2. Beam torsion

2.2.1. St Venant's theory of beam torsion
- Introduction
- St. Venant's solution

2.2.2. Prandtl's solution of beam torsion

2.2.3. Approximate solutions for torsion of thin-walled structures
- Introduction
- Open cross-section beams
- Closed cross-section beams
- Torsion of beams with variable cross-sections

2.2.4. A brief incursion into aeroelasticity

3. ENERGY METHODS

3.1. Work and potential energy principles

3.1.1. Introduction
3.1.2. Work and potential energy
3.1.3. Virtual work and virtual potential energy
3.1.4. Variational operator
3.1.5. Principle of virtual work (PVW)
- PVW for a rigid system
- PVW for a deformable body
- PVW for conservative systems

3.1.6. Complementary virtual work and associated principles

3.2. Analytical solutions of static problems using energy methods

3.2.1. Castigliano's theorems
- Introduction
- Computation of the (complementary) strain energy for simple systems
- Castigliano's theorems

3.2.2. Statically determinate structures
3.2.3. Statically inderterminate structures

4. INTRODUCTION TO BUCKLING

4.1. Introduction
4.2. Beam buckling using Euler-Bernoulli theory
4.3. Beam buckling using energy methods