Course Registration Numbers: 52120

Schedule: MWF 9:30 – 10:20 am; KNOY B033

Instructor: Michael D. Sangid; Email: msangid@purdue.edu
Office: 3329 ARMS; Telephone: 494-0146
Office Hours: 10:20 – 11:20 am on Wednesdays and 3 – 4 pm on Thursdays, additionally I will be available briefly after each class or by appointment

TA: Clifford Skelton Email: cskelto@purdue.edu
Office Hours: Clifford will hold regular office hours for HW assistance. *Thursdays 1:30 – 3 pm in room B159 ARMS.* Please seek HW help in the scheduled office hours of the TA (preferred) or by emailing the TA first, if possible.

Prerequisites: AAE 204 / AAE 204L – Aeromechanics II (Course and Lab)

Required Text: T.A. Weisshaar. *Aerospace Structures – an Introduction to Fundamental Problems*, Course Notes, 2011. *Available on the website*.

Recommended Text: C.T. Sun. *Mechanics of Aircraft Structures*, Second Edition. John Wiley & Sons. 2006.

Supplemental Texts: James M Gere & Barry J. Goodno, *Mechanics of Materials*, Cenage Learning, 7th Edition, 2009.
D. J. Peery and J. J. Azar, *Aircraft Structures*, McGraw-Hill, 1982

Course Website:
https://engineering.purdue.edu/AAE/Academics/Courses/aae352/2012/fall
The current schedule as well as supplementary information will be kept on the website. The course notes, reading material, hw, etc will be found in the restricted access folder.

Course Description: Properties of wing and fuselage sections. Buckling of beams and plates. Torsion of thin-walled and skin-stringer multiple-cell sections. Failure mechanisms and predictions. Nonsymmetrical bending of skin-stringer sections. Flexural shear in open and closed thin-walled and skin-stringer sections. Deflection by energy method. Introduction to composite structures.

Course Goals & Objectives: The objective is to develop concepts needed to analyze and design minimum weight aerospace structures. To this end, emphasis is placed on the following topics:

1. Analytical/empirical tools for determining the distribution of load (or displacement) in typical aerospace components.

2. Procedures for relating applied loads (or displacements) to component "failure."
3. Selection of materials to resist structural failure.
4. Other professional development topics are also be presented as time permits (e.g., technical communications, teamwork issues, economic considerations, engineering ethics, case histories, regulatory & certification topics, etc.)

Necessary Background:

1. Vector calculus and differential equations
2. Statics and mechanics of materials

Topics:

1. Review of strength of materials and introduction to elasticity (4 classes)
2. Design criteria and determination of loads (6 classes)
3. Materials selection and evaluation (8 classes)
4. Bending and torsion of thin-walled structures (13 classes)
5. Buckling design of structural elements (6 classes)
6. Deflection analysis of structures (6 classes)
7. Tests (2 classes & final exam)

Relationship of Course to Program Objectives: This is the final required structural analysis course in the AAE undergraduate curriculum and is specifically directed at Program Objective I.1. The course focuses on techniques for analyzing and designing semi-monocoque structure common to the aerospace industry. Knowledge of design (I.5) is included through lectures and homework problems that deal with component sizing and materials selection to design minimum weight structures that resist structural failure. Basic engineering skills (Program objective II) are addressed through open-ended homework assignments (II.1.c) and written reports (II.3.1) that require students to formulate and solve various structural analysis and design problems (II.1). These assignments often require use of computational methods and tools (II.1.a) to perform parametric studies. Depending on the instructor, some projects may involve teamwork (II.2) and oral reports (II.3.b). Class discussion of structural design case histories and professional development issues address Program Objectives II.3.b, II.4, and IV.

Approach: Active learning – classes are a mixture of lecture and discussion
Students are expected to be present and prompt for class, to keep up with the materials and homework assignments, and to live up to the highest standards of honesty and integrity. Lectures will include presentation of concepts and methods and working of examples. A typical class period will include a lecture highlighting the important concepts and integrating examples. Students are encouraged and expected to be lively and participate with the lectures.

Projects: A project allows the student to dive deeply into one of the concepts overviewed during the semester. The project will be covered more in detail later, but will consist of a team exercise including an in-class presentation and a documented solution to an aerospace problem using the tool you investigated. Deliverables of the project include a 5 minute presentation and executive summary of the problem and solution.

Grading: 3 Credit Hours – HW (20%), Midterm 1 (20%), Midterm 2 (20%), Final (20%), Project (15%), and In-Class Participation & Exercises (5%). In general, we will have a 90%|80%|70%|60% grade scale with +/- grades. Depending on how the class performs on its assignments and tests, the instructor reserves the right to curve the scale in the favor of the class, if necessary, based on his discretion. Grades will never be curved downward.

Homework: Assigned weekly on the previous Friday/Monday and due on the following Friday. You are allowed to drop the lowest score out of the 10 HW assignments.

The HW is for your own benefit and is necessary to properly learn the material. It is expect that each student put forward an honest effort in solving each problem and turns in his or her own work. Please contact Clifford Skelton, the TA, with any questions.

Definition of Academic Dishonesty: Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" (*University Regulations*, Part 5, Section III, B, 2, a). Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" (University Senate Document 72-18, December 15, 1972).

Academic Integrity: "Purdue University values intellectual integrity and the highest standards of academic conduct. To be prepared to meet societal needs as leaders and role models, students must be educated in an ethical learning environment that promotes a high standard of honor in scholastic work. Academic dishonesty undermines institutional integrity and threatens the academic fabric of Purdue University. Dishonesty is not an acceptable avenue to success. It diminishes the quality of a Purdue education which is valued because of Purdue's high academic standards" (S. Akers, *Academic Integrity, A Guide for Students*, 1995, revised 1999). Also, see PURDUE UNIVERSITY CODE OF HONOR

Honors Credit: It is possible to take AAE352 for honors credit with approval from the instructor. The idea of extra projects involving teaching others (in some form of outreach) what you've learned in the class has always been appealing. Wikipedia is a very powerful tool for this, although a lot of resources already exist for aerospace structural analysis. An honors class project for AAE 352 will consist of creating/modifying a Wikipedia page with concepts, applications, and/or examples from aerospace structural analysis (with your choice of topics from class). The topic is due on Friday, November 2nd, 2012. Please include a printout of the original page that you intend to modify or the search result containing no wiki found for that topic. The project is due Friday, November 30th, 2012. Please email me a URL link to your Wikipedia website and turn in a printout of the page.

Project

Requirements

- Teams of 4-5 students will be assigned by the instructor
- Must actually solve a problem by engineering analysis

Deliverables

- Proposal which includes: group members, topic, proposed analysis, expected outcomes – due Nov 12
- One page Executive Summary highlighting the important parts of the project. This should be a self-contained report including the motivation, problem, discussion, and solution. Additional analyses, figures, tables, and references can be added as appendices, which will not count in your 1 page maximum requirement – due at the time of the presentation
- Five Minute Presentation in front of the class – Week of Dec 3, 2012; exact time/place TBD

Topics (include but not limited to):

- Look at a specific aircraft failure: why did it occur, what was the failure mode, perform an engineering analysis to model the failure
- Finite element analysis (static or dynamic): learn, apply and demonstrate a commercial FEA package solving an aerospace problem
- Composite materials and structures
- Metallic materials and structures
- Smart or multi-functional structures
- Dynamic instabilities such as flutter
- Static instabilities: buckling of plates and shells
- Loading: rotational loading
- Heat transfer and structural loading
- Manufacturing processes for aircraft
- Design some component of an aircraft: wing or fuselage structure
- Aero-elasticity

Students with Disabilities: Students with disabilities requiring additional assistance should make themselves known to the instructor.

Campus Emergency: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control.

Additional Information: This class will uphold Purdue University's policies on 'Attendance and Grief Absence', 'Adverse Weather', 'Campus Emergency', etc. Please consult purdue.edu for more information.

	Lecture Date	***Material to Cover***	***Reading***	***HW***
Week 1				
1	M 8/20/12	Lect1: Syllabus and Overview	2.1-2.4	
2	W 8/22/12	Lect2: Trusses: Issues and Review	2.5-2.8	
3	F 8/24/12	Lect3: Trusses: Weight and Design	2.9-2.13	HW 1 - Assigned
Week 2				
4	M 8/27/12	Lect4: Inertia Loads	3.1-3.4	
5	W 8/29/12	Lect5: Load Factors and Rotation	3.5-3.9	
6	F 8/31/12	Lect6: Inertia Loads and Moments	3.10-3.12	HW 1 - Due
Week 3				
	M 9/3/12	No Class - Labor Day		HW 2 - Assigned
7	W 9/5/12	Lect7: Inertia Loads and Examples ***		
8	F 9/7/12	Discussion: Strength Materials and Elasticity		HW 2 - Due
Week 4				
9	M 9/10/12	Lect8: Matrix Methods-1 ***		HW 3 - Assigned
10	W 9/12/12	Lect9: Matrix Methods-2		
11	F 9/14/12	Lect10: Matrix Methods-3 Thermal Loads		HW 3 - Due
Week 5				
12	M 9/17/12	Lect11: Matrix Methods-4 Transformations		
13	W 9/19/12	Lect12: Matrix Methods-5 Angular Transf.		
14	F 9/21/12	Midterm I Review		HW 4 - Assigned
Week 6				
15	M 9/24/12	Class Canceled		
(*)	Tu 9/25/12	Midterm I (1-14): 6:30-7:30, EE 129		
16	W 9/26/12	Lect13: Matrix Methods Examples		
17	F 9/28/12	Discussion: Finite Element Approaches		HW 4 - Due
Week 7				
18	M 10/1/12	Lect14: Material Selection-1		HW 5 - Assigned
19	W 10/3/12	Lect15: Elasticity and Buckling-1		HW 6 - Assigned
20	F 10/5/12	Lect16: Elasticity and Buckling-2		HW 5 - Due
Week 8				
	M 10/8/12	No Class - October Break		
21	W 10/10/12	Lect17: Yielding and Plasticity		
22	F 10/12/12	Lect18: Fracture-1		HW 6 - Due
Week 9				
23	M 10/15/12	Lect19: Fracture-2		HW 7 - Assigned
24	W 10/17/12	Lect20: Material Selection-2		
25	F 10/19/12	Lect21: Fatigue		HW 7 - Due

Week 10			
26	M 10/22/12	Lect22: Material Selection-3 ***	HW 8 - Assigned
27	W 10/24/12	Lect23: Fatigue and Fracture	
28	F 10/26/12	Lect24: Material Design	HW 8 - Due
Week 11			
29	M 10/29/12	Discussion on Material Failure	HW 9 - Assigned
30	W 10/31/12	Lect25: Review of Beam Bending and Shear	
31	F 11/2/12	Lect26: Shear Stresses in Beams	HW 9 - Due
Week 12			
32	M 11/5/12	Midterm II Review	
(*)	Tu 11/6/12	Midterm II (16-32): 6:30 - 7:30, EE 129	
33	W 11/7/12	Lect27: Skin-Stringer Approximations	
34	F 11/9/12	Lect28: Shear Flow; Resultant Forces	HW 10 - Assigned
Week 13			
35	M 11/12/12	Lect29: Torsion of Thin-Walled Sections	Project Proposals
36	W 11/14/12	Lect30: Closed Cell Shear Center	
37	F 11/16/12	Lect31: Shear Flow in Closed Sections	HW 10 - Due
Week 14			
38	M 11/19/12	Lecture32: Closed Sections	HW 11 - Assigned
	W 11/21/12	No Class - Thanksgiving Break	
	F 11/23/12	No Class - Thanksgiving Break	
Week 15			
39	M 11/26/12	Lect33: Torsion of Open Sections	
40	W 11/28/12	Lect34: Stability-1	
41	F 11/30/12	Lect35: Stability-2	HW 11 - Due
Week 16			
42	M 12/3/12	Lect36: Stability-3	
##	TBD	Project Presentations	
43	W 12/5/12	Lect37: Stability and Design	
44	F 12/7/12	Review for Final	
Week 17			
(*)	TBD	Final Exam (33 - 44)	

(*) Indicates an Exam
*** Guest Lecturer