Course Registration Numbers: 62157

Schedule: TuTh 10:30 – 11:45 am; LWSN B155

Instructor: Michael D. Sangid; Email: msangid@purdue.edu
Office: 3329 ARMS; Telephone: 494-0146
Office Hours: 3-4 pm on Wednesdays, additionally I will be available briefly before/after each class or by appointment. Office hours will initially held in my office. For assistance with HW, contact the TA (not the instructor).

TA: Banghua Zhao Email: zhao563@purdue.edu
Office Hours: Banghua will hold regular office hours for HW assistance. ***Mondays 5:30 – 7:30 pm in room 2119 ARMS.*** Note on Sept 12 office hours will be held in HAMP 1144. Please seek HW help in the scheduled office hours of the TA (preferred) or by emailing the TA.

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:
- T.G.H. Megson, *Intro to Aircraft Structural Analysis*, Butterworth-Heinemann, 2nd Ed, 2014.
- 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 Ed, 2009.
- D. J. Peery and J. J. Azar, *Aircraft Structures*, McGraw-Hill, 1982

Course Website:
The current schedule as well as supplementary information will be kept on the Purdue's blackboard. The course notes, reading material, hw, etc will be found on blackboard, as well.

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: Two projects allow 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 a documented solution to an aerospace design problem using the structural analysis tools developed in this class. Deliverables of the project include:

- 1 page executive summary, including description of the design problem and solution
- Appendix with figures, analysis, and details of the solution

Students with Disabilities: Students with disabilities requiring additional assistance should make themselves known to the instructor.
Grading: 3 Credit Hours – HW (25%), 3 Exams (each worth 15%), 2 Projects (each worth 12.5%), 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 Thursday (given on website) and due on the following Tuesday. You are allowed to drop the lowest score out of the 11 HW assignments. You may work in teams of 1 to 4 on the HW. Please write each of your names on the HW assignment that you turn in.

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. Working together is not a means to 'divide up' the work. If you turn in an assignment with more than one name on it; each person must have put forth their best effort on every problem and discussed this problem with the group. Any abuse of this policy and we will go back to individual assignments. Please contact Banghua Zhao, 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 Thursday, November 3rd, 2016. 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 Tuesday, November 22nd, 2016. Please email me a URL link to your Wikipedia website and turn in a printout of the page.

Project

Requirements

- Teams of 3-4 students will be assigned by the instructor
- Must actually solve a design problem by engineering structural analysis

Deliverables

- 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. Appendices are strongly recommended to improve your project grade.
- Each student will fill out a peer evaluation expressing their teammates' enthusiasm and contribution to the project.
- The Executive Summary, Appendices, and Peer Reviews are due by the dates indicated below. Reports can be slide under the instructor's door of his office in ARMS 3329. Please note that the 3rd floor office hallway is closed and lock at 5 pm on weekdays.

Q & A

- These projects are design competitions between groups to mimic the industrial bidding process for contract work. Thus, in order to make it fair for everyone, the instructor will answer questions about the project during class hours (at the beginning/end of class) during the first week that the project is assigned. Any questions asked over emails will go on a question/answer document on the course website for everyone to see (again during the first week that the project is assigned). After the first week has passed, the teams are to complete the project on their own and should exercise their best judgment.

Topics:

- Failure analysis and redesign for a case study of fracture mechanics
    - Project I: Assigned Tuesday 10/25/16 and Due Tuesday 11/15/16
- Design for weight reduction of a skin-stringer wing structure, while still meeting strength and material requirements.
    - Project II: Assigned Thursday 11/07/16 and Due Thursday 12/08/16

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 Weishaar***	***Reading Megson***	***HW / Projects***
Week 1					
	Tu 8/23/16	Lect1: Syllabus and Overview	Ch1		
	Th 8/25/16	Lect2: Trusses: Issues and Review	2.1-2.8		
Week 2					
	Tu 8/30/16	Lect3: Trusses: Weight and Design	2.9-2.13		HW 1 - Due
	Th 9/01/16	Lect4: Euler Buckling	Ch8	8.1-8.2	
Week 3					
	Tu 9/6/16	Lect5: Matrix Methods-1	4.1-4.5	6.1-6.4	HW 2 - Due
	Th 9/8/16	Lect6: Matrix Methods-2	4.6-4.7		
Week 4					
	Tu 9/13/16	Lect7: Matrix Methods-3 Thermal Loads			HW 3 - Due
	Th 9/15/16	Lect8: Matrix Methods-4 Angular Transform	4.8-4.12		
Week 5					
	Tu 9/20/16	Lect9: Multi-axial Failure Theories			HW 4 - Due
	Th 9/22/16	Lect10: Stress Concentration & Fracture-1	5.7	14.5	
Week 6					
	Tu 09/27/16	Lect11: Review for Exam 1			
	Th 09/29/16	Lect12: Fracture 2			
(*)	Th 09/29/16	**Exam I (L1-8; HW1-4): 6:30-7:30 pm; ARMS 1010**			
Week 7					
	Tu 10/04/16	Lect13: Material Selection-1	5.1-5.5	10	HW 5 - Due
#	Th 10/06/16	Lect14: Material Selection-2	5.6		
Week 8					
X	Tu 10/11/16	No Class - October Break			
X	Th 10/13/16	No Class			
Week 9					
	Tu 10/18/16	Lect15: Fatigue-1	5.8	14.1-14.5	HW 6 - Due
	Th 10/20/16	Lect16: Fatigue-2 and FCG			
Week 10					
	Tu 10/25/16	Lect17: FCG and Project I Description			HW 7 - Due
	Th 10/27/16	Lect18: Composites-1			
Week 11					
	Tu 11/01/16	Lect19: Composites-2 and Review for Exam 2			
(*)	**W 11/02/16**	**Exam II (L9-17; HW5-7): 6:30-7:30 pm; ARMS1010**			
	Th 11/03/16	Lect20: Review of Beam Bending and Shear	6.1-6.4	15.1-4,16	
Week 12					
	Tu 11/08/16	Lect21: Skin-Stringer Approximations	7.1-7.2	19	HW 8 - Due
	Th 11/10/16	Lect22: Shear Flow; Resultant Forces	Ch7	18	
Week 13					
	Tu 11/15/16	Lect23: Torsion of Thin-Walled Sections		17	HW 9 & Project I
	Th 11/17/16	Lect24: Shear Flow & Project II Description	7.1-7.2	20-22	
Week 14					
	Tu 11/22/16	Lect25: Closed Sections-1			
X	W 11/24/16	No Class - Thanksgiving Break			
Week 15					
#	Tu 11/29/16	Lect26: Closed Sections-2 & Examples			HW 10 - Due
	Th 12/01/16	Lect27: Inertia Loads and Load Factors	3.1-3.9	13.1-13.3	
Week 16					
	Tu 12/06/16	Lect28: Inertia Loads and Moments	3.10-3.12		HW 11 - Due
	Th 12/08/16	Lect29: Review for Exam 3			Project II - Due

X Indicates 'No Class' on this date
(*) Indicates an Exam
# Indicates a Guest Lecturer

EMERGENCY PREPAREDNESS SYLLABUS ATTACHMENT

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

- **Indoor Fire Alarms** mean to stop class or research and immediately **evacuate** the building.
  - Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.
- **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building.
  - "Shelter in place" means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, a civil disturbance including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

**In both cases, you should seek additional clarifying information by all means possible…Purdue Emergency Status page, text message, Twitter, Desktop Alert, Albertus Beacon, digital signs, email alert, TV, radio, etc…review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html*

EMERGENCY RESPONSE PROCEDURES:

- Review the **Emergency Procedures Guidelines** https://www.purdue.edu/emergency_preparedness/flipchart/index.html
- Review the **Building Emergency Plan** (available on the Emergency Preparedness website or from the building deputy) for:
  - evacuation routes, exit points, and emergency assembly area
  - when and how to evacuate the building.
  - shelter in place procedures and locations
  - additional building specific procedures and requirements.

EMERGENCY PREPAREDNESS AWARENESS VIDEOS

- "Shots Fired on Campus: When Lightning Strikes," is a 20-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See: http://www.purdue.edu/securePurdue/news/2010/emergency-preparedness-shots-fired-on-campus-video.cfm (Link is also located on the EP website)

MORE INFORMATION

Reference the Emergency Preparedness web site for additional information: https://www.purdue.edu/ehps/emergency_preparedness/