

**Course Registration Numbers:** 52120

**Schedule:** MWF 9:30 – 10:20 am; ARMS B071

**Instructor:** Michael D. Sangid; Email: msangid@purdue.edu  
Office: 3329 ARMS; Telephone: 494-0146  
Office Hours: 3- 4 pm on Tuesdays, additionally I will be available briefly before/after each class or by appointment. Office hours will initially held in my office, but if there are many students we will move to ARMS 3118.

**TA:** Javier Esquivel Email: jesquiv@purdue.edu  
Office Hours: Javier will hold regular office hours for HW assistance. *Tuesdays 4 - 5:30 pm in room 3118 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*, Cengage Learning, 7<sup>th</sup> Edition, 2009.

D. J. Peery and J. J. Azar, *Aircraft Structures*, McGraw-Hill, 1982

**Course Website:**

<https://engineering.purdue.edu/AAE/Academics/Courses/aae352/2013>

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:** Three 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 (20%), 3 Exams (each worth 15%), 3 Projects (each worth 10%), 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 (given on website) and due on the following Wednesday. 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 Javier Esquivel, 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 1st, 2013. 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 Monday, November 25th, 2013. 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:*

- Design for weight reduction of an aircraft truss structure, while still meeting strength and material requirements, using matrix methods.
  - Project I: Assigned Friday 9/20/13 and Due Friday 10/4/13
- Failure analysis and redesign for a case study of fracture mechanics
  - Project II: Assigned Friday 10/25/13 and Due Friday 11/8/13
- Design of a skin-stringer assembly for aircraft use, while meeting strength/material requirements.
  - Project III: Assigned Friday 11/22/13 and Due Wednesday 12/11/13

**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](http://purdue.edu) for more information.

<u>Lecture Date</u>	<u>Material to Cover</u>	<u>Reading</u>	<u>HW</u>	<u>Projects</u>
Week 1				
M 8/19/13	Lect1: Syllabus and Overview	Ch1		
W 8/21/13	Lect2: Trusses: Issues and Review-1	2.1-2.4		
F 8/23/13	Lect3: Trusses: Issues and Review-2	2.5-2.8	HW 1 - Assigned	
Week 2				
M 8/26/13	Lect4: Trusses: Weight and Design	2.9-2.13		
W 8/28/13	Lect5: Euler Buckling	Ch8	HW 1 - Due	
F 8/30/13	Lect6: Stability		HW 2 - Assigned	
Week 3				
X M 9/2/13	No Class - Labor Day			
W 9/4/13	Lect7: Inertia Loads	3.1-3.4	HW 2 - Due	
F 9/6/13	Lect8: Load Factors and Rotation	3.5-3.9	HW 3 - Assigned	
Week 4				
# M 9/9/13	Lect9: Inertia Loads and Moments	3.10-3.12		
W 9/11/13	Lect10: Inertia Loads and Examples		HW 3 - Due	
F 9/13/13	Lect11: Matrix Methods-1	4.1-4.5	HW 4 - Assigned	
Week 5				
M 9/16/13	Lect12: Matrix Methods-2	4.6-4.7		
W 9/18/13	Lect13: Matrix Methods-3 Thermal Loads		HW 4 - Due	
F 9/20/13	Lect14: Exam I Rev. & Project I Description			P I - Assigned
Week 6				
M 9/23/13	Lect15: Matrix Methods-4 Transformations	4.8-4.9		
(* ) Tu 9/24/13	Exam I (L1-14; HW1-4): 6:30-7:30 pm; PHYS 233			
W 9/25/13	Lect16: Matrix Methods-5 Angular Transform	4.10-4.12	HW 5 - Assigned	
F 9/27/13	Lect17: Matrix Methods-6 Examples			

Week 7					
M 9/30/13	Lect18: Material Selection-1	5.1-5.5			
W 10/2/13	Lect19: Material Selection-2	5.6		HW 5 - Due	
F 10/4/13	Lect20: Material Selection-3			HW 6 - Assigned	P I - Due
Week 8					
X M 10/7/13	No Class - October Break				
W 10/9/13	Lect21: Multi-axial Failure Theories			HW 6 - Due	
F 10/11/13	Lect22: Stress Concentration & Fracture-1	5.7		HW 7 - Assigned	
Week 9					
M 10/14/13	Lect23: Fracture-2				
W 10/16/13	Lect24: Fatigue-1	5.8		HW 7 - Due	
F 10/18/13	Lect25: Fatigue-2			HW 8 - Assigned	
Week 10					
M 10/21/13	Lect26: Fatigue Crack Growth-1				
W 10/23/13	Lect27: Fatigue Crack Growth-2				
F 10/25/13	Lect28: Exam II Rev. & Project II Description			HW 8 - Due	P II - Assigned
Week 11					
## M 10/28/13	Lect29: Composites-1				
(* Tu 10/29/13	Exam II (L15-28; HW5-8): 6:30-7:30 pm; PHYS 233				
## W 10/30/13	Lect30: Composites-2				
# F 11/1/13	Lect31: Review of Beam Bending and Shear	6.1-6.4		HW 9 - Assigned	
Week 12					
M 11/4/13	Lect32: Shear Stresses in Beams				
W 11/6/13	Lect33: Skin-Stringer Approximations	7.1-7.2		HW 9 - Due	
F 11/8/13	Lect34: Shear Flow, Resultant Forces	Ch7		HW 10 - Assigned	P II - Due
Week 13					
M 11/12/13	Lect35: Torsion of Thin-Walled Sections				
W 11/13/13	Lect36: Closed Cell Shear Center			HW 10 - Due	
F 11/15/13	Lect37: Shear Flow in Closed Sections			HW 11 - Assigned	

Week 14			
M 11/18/13	Lect38: Closed Sections-1		
W 11/20/13	Lect39: Closed Sections-2	HW 11 - Due	
F 11/22/13	Lect40: Exam III Rev. & Project III Description		P III - Assigned
Week 15			
M 11/25/13	Lect41: Skin-Stringer Examples		
(*) M 11/25/13	Exam III (L29-41; HW9-11): 6:30-7:30 pm; PHYS 233		
X W 11/27/13	No Class - Thanksgiving Break		
X F 11/29/13	No Class - Thanksgiving Break		
Week 16			
X M 12/2/13	No Class - Conference		
X W 12/4/13	No Class - Conference		
X F 12/6/13	No Class - Conference		
Week 17			
X W 12/11/13			P III - Due

X Indicates 'No Class' on this date

(\*) Indicates an Exam

# or ## Indicates a Guest Lecturer

Exams are in the evening at 6:30-7:30 pm in PHYS 233  
On Tuesday 9/24; Tuesday, 10/29; Monday, 11/25