San José State University
Aerospace Engineering Department

AE 250
ADVANCED AEROSPACE STRUCTURES AND MATERIALS
Metal vs. Composite structures
Fall 2014

Course and Contact Information

Instructor:	Cecilia Larrosa
Office Location:	TBD
Email:	clarrosa@exponent.com
Office Hours:	TBD and by appointment
Class Days/Time:	Thursdays 18:00 – 20:45
Classroom:	ENG 164
Prerequisites:	Introductory courses on solid mechanics, mechanics of materials and aerospace structures (AE114), familiarity with Matlab®

Course Description

This course introduces the analysis and design of structures composed of fiber reinforced composite materials. The major focus is on aeronautical and astronautical applications, but other engineering disciplines may be explored through the course project. Analysis and design of structures composed of isotropic materials, like metals, are part of the aerospace structural analysis curriculum. However, the increasing use of composite materials for aerospace structures requires engineers to be familiar with the analysis of composite structures as well. Hence, the course will first review the stress and failure analysis of metallic structures. The second part of the course will introduce composite materials as well as stress analysis, design and failure of composite structures. Students will gain experience in the analysis of both metallic and composite structures and compare and reflect on the use of these materials for a structural design through the course project.

Learning Outcomes

At the end of this course students will be able to:

1) Resolve the pertinent stresses affecting metallic and composite structures.
2) Identify when and how structural failure can occur.
3) Examine an existing structure, choose and employ the appropriate concepts/methods to answer the following questions:
    a. Is it going to fail? Or
    b. What is needed to avoid failure?
    c. How might the design be improved?
    d. What are the advantages/disadvantages of using different materials?

Required Texts

Textbook (Required)

L.P. Kollar and G.S. Springer, *Mechanics of Composites Structures*, Cambridge University Press

Other Useful Resources

C.T. Sun, *Mechanics of aircraft structures*, John Wiley and Sons (Reference for Weeks 2-4)

Megson, *Aircraft Structures for Engineering students*, Elsevier (Reference for Weeks 2-4)
http://discover.sjlibrary.org/iii/encore_sjsu/record/C__Rb4342559

T.L. Anderson, *Fracture Mechanics: fundamentals and applications*, Third Edition, Taylor and Francis (Reference for Weeks 5-6)

Various handouts to be posted online

https://www.efatigue.com/efatigue.html

Course Requirements and Assignments

Lecture and in-class participation

In-class participation is very important since lectures will be interactive and collaborative. Students will be asked to work in teams and report on their findings/ideas to the class. In-class demonstrations, examples and group exercises are meant to develop understanding of concepts and problem solving skills. Additionally, these exercises will involve collaboration with others the same way it is done in industry and research teams.

Homework assignments:

- Assignments are due in class on Thursdays, unless specified otherwise. Solutions will be posted after class.
- Students are encouraged to work in collaboration with others as long as you (the student) turn in your own work.
- It is expected that your assignments will present a clean and organized thought process and methodology to solve the problem at hand. Think of it as presenting this to your supervisor at work, who did not necessarily work with you but needs to know all the steps you took in order to approve your design/analysis.

Course project:

The project will be discussed more in detail during lecture and on a separate handout. Each team/student will choose an interesting system/structure to be analyzed using the different methods presented in the course. The final report will involve a reflection, comparison and recommendations about the use of metal or composites.
It is broken down into 3 parts (due dates in course schedule):

1) Stress and failure analysis of metallic structure.
2) Stress analysis and design of composite structure.
3) Failure analysis of composite structure. Comparison and recommendations.

Grading Policy

4 Homework assignments	20%	Due as per schedule
Exam 1	15%	October 9th, 2014

Exam 2	15%		November 20th, 2014
Course Project	50% ;		
Parts 1 & 2		35%	Due as per schedule
Part 3 and Final report		15%	December 18th,2014

AE 250 – Fall 2014 Course Schedule

Course Schedule

Week	Date	Content / Topics	Assignments
1	28-Aug	Introduction Materials and stress/strain, pressure Vessels	
2	4-Sep	Torsion Torsion	
3	11-Sep	Bending Bending + Torsion	HW #1 due: pressure vessels & torsion
4	18-Sep	Buckling Failure modes, failure criteria	
5	25-Sep	Fracture mechanisms, Thermodynamics of fracture. Linear Elastic Fracture Mechanics (fracture toughness and critical length) examples - project discussion	HW #2 due: bending, Failure criterias & buckling
6	2-Oct	Fatigue mechanisms and design strategies Stress life approach example, review for exam	
7	9-Oct	**Exam 1**	
8	16-Oct	Composites: Intro and manufacturing Composites - Lamina: Stress and strain, testing to get properties, strength	Project Part I: Stress Analysis & Failure of isotropic structure
9	23-Oct	Composites - Laminates: Lamination Theory	HW#3 due: Composites - getting properties from exp data, and angle transformation
10	30-Oct	Composites : thermal stresses Composites: beams and bending general	
11	6-Nov	Composites: thin wall open section bending Composites: closed thin wall section bending	HW #4 due: Composites - lamination theory matlab code
12	13-Nov	Composites:review bending, torsion Composites square tube example	
13	20-Nov	**Exam 2**	
14	27-Nov	Thanksgiving break - no class	
16	4-Dec	Composites Failure criterias and damage tolerance	Project Part 2:Composite Design and Stress analysis.
17	11-Dec		
	18-Dec	Project Part 3: Failure analysis of composites; Comparison and recommendations	