USC Viterbi School of Engineering

AME 585 – Aerospace Structures II
Spring 2018
Monday 4:10-6:20pm

Location: TBD

Instructor: Vinay Goyal
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Teaching Assistant: TBD

Course Description

This course is the continuation of Aerospace Structures I. The course will discuss analysis of bonded joints, repairs in aircraft/launch vehicles, fracture control requirements and analysis, analysis of pressurized vessels, analysis or pressurized components, analysis and tests of ball bearings, flexible dynamics for spacecraft, random vibration, deployable spacecraft components, and certification of thermal protection systems, and practical finite element analysis for space applications.

Learning Objectives
Practical concepts in the analysis and design of aircraft, launch vehicles, and space structures will be discussed. Students are expected to learn:
(1) Analysis and Testing of Repairs
(2) Bonded Joints
(3) Fracture Control Requirements
(4) Dynamics of Spacecraft
(5) Mechanisms and Pressurized Structures in Space Applications
(6) Practical Finite Elements as Applied to Space Structures

Prerequisite(s): AME 485
Co-Requisite (s): None
Concurrent Enrollment: None
Recommended Preparation: None

Course Notes
Copies of lecture slides and other class information will be posted online.

Technological Proficiency and Hardware/Software Required
Mathematica, Matlab Not Required, but may be needed.

Required Readings and Supplementary Materials

Primary Textbook: Spacecraft Structures and Mechanisms, From Concept to Launch: Thomas P. Sarafin

Optional Textbooks:

(1) Spacecraft Structures, J. Wijker, Springer
(2) Space Vehicle Design, Griffin and French
(3) Analysis and Design of Structural Bonded Joints, Liyong Tong

Description and Assessment of Assignments

Homework will be assigned approximately weekly and will be due at the beginning of class one week after the date assigned.

Grading Breakdown

Weekly Homework – 100%

Grading Scale

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Rubrics

N/A

Assignment Submission Policy

Homework will be submitted to professor. Late assignments will not be accepted.

Grading Timeline

Graded homework will be returned weekly.

Additional Policies

No late assignments will be accepted. Class attendance is mandatory.

Course Schedule: Weekly Breakdown

	Topics/Daily Activities	Readings and Homework	Deliverable/ Due Dates
Week 1	Introductory Remarks: Aircraft, Launch Vehicle, and Spacecraft	HW 1 Reading: 1st Lecture, Ch 1	
Week 2	Structural Repairs and Requirements for Repairs, Part I	Reading: 2nd Lecture, Ch 1	HW 1
Week 3	Structural Repairs and Requirements for Repairs, Part II	HW 2 Reading **2nd** Lecture, Ch 1	
Week 4	Techniques for the Analysis of Bonded Joints: Part I	**2nd** Lecture Reading Ch 2 and Investigate FAA Repairs	HW 2
Week 5	Techniques for the Analysis of Bonded Joints: Part II	HW 3; Reading Ch 3 and Investigate techniques for good bonding process	
Week 6	Fatigue Analysis Mechanisms	HW 4; Reading Ch 3 and Investigate methods for detecting fatigue damage in aircraft	HW 3
Week 7	Fatigue Analysis High Cycle Fatigue, Part I	Reading Ch 4 and Investigate HCF of multiple metals, and influence of surface finish and AM parts	HW 4
Week 8	Fatigue Analysis High Cycle Fatigue, Part II	HW 5 Reading Ch4, and Investigate HCF for composites	
Week 9	Fatigue Analysis Low Cycle Fatigue		HW 5
Week 11	Fracture Control Requirements for Space Systems: History, Applications, and Practical Considerations: Part I	Reading: Investigate methods to inspect crack growth in metals	HW
Week 12	Fracture Control Requirements for Space Systems: History, Applications, and Practical Considerations: Part II	HW 6 Reading: Investigate methods to inspect damage in composites	
Week 13	Spacecraft Design Loads , Spacecraft Design Requirements and Environments, Space Mission Requirements	HW 7 Reading: Ch 5-6	HW 6
Week 14	Random Vibration Analysis for Space Components	HW 8 Reading: Ch 7-8	HW 7
Week 15	Analysis and Test Requirements for Pressurized Components: Bellows, Valves, Actuators, and COPVs	HW 9 Reading: Course Handouts will be provided	HW 8
Week 16	Analysis of Ball Bearings in Space Applications	HW 10, Final Exam Take-Home Reading: Investigate types of failures of bearings	HW 9
FINAL			HW 10

Assignments

The assignments are individual projects that entail developing a power point presentation addressing various topics in aircraft structures. All assignments require many hours of work and dedication from students considering the fact that they cannot answer the assignments just with the materials provided during lectures forcing them to read several book chapters, papers, and manuals.

Assignment 1: Perform a literature survey of fatigue crack growth leading to either in-flight incidence of failures and lessons learned due to these failures. Provide failure modes occurring in launch vehicles and aircraft structures. Perform a survey of techniques for repairs in aircraft structures and provide advantages and disadvantages of each repair method.

Assignment 2: Perform a comprehensive survey of NDE techniques used in aircraft and launch vehicles and compare them. Provide advantages and disadvantages of each technique. Explore pressure sensitive paint for detecting damage in composites. Select several film adhesives and epoxies used in aircraft and launch vehicles and compare them, examples include, AF191, FM-300, EA9394 and EA9396. What are the advantages and disadvantages of epoxy vs film adhesive?

Assignment 3: Research composite drilling and the type of damage it can cause. Perform research relative to bearing, bypass, and net section failure of composite bolted connections. Numerical practical homework.

Assignment 4: Examine hydrogen embrittlement, hydrogen assisted cracking and its detrimental effects in aircraft and launch vehicles. Investigate aircraft crashworthiness and perform an investigation of fretting and galling mechanisms, considered fatigue damage.

Assignment 5: Examine the A380 fan blade out test and provide critical comments. Perform observations and critical review of the shuttle main engine reliability relative to fatigue crack growth. Perform research on the manufacturing of AM parts and comment on the fatigue and fracture performance of these parts compared to traditional parts. Finally, perform research on ball bearing damage and test and analytical models that are used to assess these structural components.

Assignment 6: Practical Numerical homework involving LCF and HCF.

Assignment 7: Practical numerical homework involving fatigue crack growth using commercial fracture software.

Assignment 8: Perform research in the area of the design of spacecraft. Will provide a set of guidelines for this research and a presentation for this homework will be required.

Assignment 9: Numerical practical homework in the area of random vibration and dynamics of launch and aircraft structures.

Assignment 10: Final homework will combine multiple aspects, LCF, HCF, fatigue crack growth, and dynamics as it applies to launch and aircraft structures.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/student/scampus/part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, intimate partner violence, stalking, and harassment are prohibited by the university. You are encouraged to report all incidents to the *Office of Equity and Diversity/Title IX Office* http://equity.usc.edu and/or to the *Department of Public Safety* http://dps.usc.edu. This is important for the health and safety of the whole USC community. Faculty and staff must report any information regarding an incident to the Title IX Coordinator who will provide outreach and information to the affected party. The sexual assault resource center webpage http://sarc.usc.edu fully describes reporting options. Relationship and Sexual Violence Services https://engemannshc.usc.edu/rsvp provides 24/7 confidential support.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://ali.usc.edu, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://dsp.usc.edu provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu will provide safety and other updates, including ways in which instruction will be continued by means of Blackboard, teleconferencing, and other technology.