AE 310 AEROSPACE STRUCTURAL ANALYSIS (3 credits)
SPRING 2007
MWF, 11:00 to 11:50 a.m.
Engineering Building, Room E 326

SYLLABUS & CLASS POLICY

Catalog description: Methods of static structural analysis of problems encountered in the flight of aerospace vehicles. Prerequisites: CE 301: Introduction to Solid Mechanics

Instructor: Dr. Satchi Venkataraman, Assistant Professor of Aerospace Engineering, Room 309 Engineering Building, (619) 594 6660, satchi@mail.sdsu.edu

Office hours: Mon. & Wed. 3:00 – 4:00 p.m. and Tue.4:30 to 5:30 p.m. and at other times by appointment.

Website: http://blackboard.sdsu.edu. The university blackboard web site will be used for disseminating course announcements and supplementary materials. Blackboard accounts use the same information as the SDSU e-services Web Portal access.

Objectives

In this course:

1. You will learn to perform simple analysis and design of aircraft structures.
2. You will become familiar with aircraft structural components, the loads acting on them, the materials used in their construction.
3. You will expand your knowledge of solid mechanics and apply it towards developing models for analyzing aerospace structures with linear elastic materials.
4. You will learn to calculate stresses and deflections of aircraft wing and fuselage type structures under axial, bending, shear and torsion loads.
5. You will learn basic concepts of failure analysis including failure criteria of metals, fracture mechanics, fatigue analysis and buckling analysis and use them to design for structural integrity.
6. You will learn how to correctly formulate the analysis problem, make physical and mathematical approximations to simplify the calculations, evaluate the correctness of numerical results, and understand the limitation of the analysis results.
7. You will work on open-ended design problems that require you to determine and ask the questions to necessary define the problem scope and develop a solution.

Lecture sessions: We will have three one hour lectures every week. Attendance is mandatory. Class lectures will generally be devoted to presentation of new material. Some lecture time will be also used to address questions and discuss practice problems that were assigned to reinforce new concepts introduced in previous lectures. Students are expected to come to class on time, turn off their cell phones before the start of class and not bring food to class. Student participation in class is encouraged to maximize the learning opportunity. Come prepared and actively participate in the discussion and learning process. Be courteous to the fellow students and the instructor during classroom discussions.

Textbook: **Mechanics of Aircraft Structures**, C. T. Sun, 2ndedition, John Wiley, 2006.

References: The course lectures will occasionally borrow material from other sources such as texts, manuals, handbooks and internet sources. Instructor will make every effort to provide references and/or copies of those materials to students in class. Although it is possible to follow the course by using the class notes, textbook and class handouts, it is suggested that students also learn to refer to additional source materials. In many cases, a different presentation may spark or enhance understanding. Thus, the following list of books is provided to serve this purpose.

Analysis and design of flight vehicle structures, E. F. Bruhn, Tri-State Offset Co., 1965.

Aircraft structures, Peery, D. J, McGraw-Hill, New York, 1949.
Theory and analysis of flight structures, R. M. Rivello, McGraw-Hill, 1969.

Aircraft Structures for Engineering Students, T. H. G. Megson, Third Edition, Elsevier, 1999..
Introduction to Aerospace Structural Analysis, D. Allen & W. Haisler, John Wiley, 1985.
Fundamentals of Aircraft Structural Analysis, Howard D. Curtis, McGraw-Hill, 1997.
Analysis of Aircraft Structures – An Introduction, B. K. Donaldson, McGraw-Hill, 1993

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Course Topics: The following topics will be covered in the course. A more detailed list of topics is provided with the course schedule. Reading material on these topics can be found in Chapters 1-7 of the textbook, class notes, supplemental handouts and suggested reading assignments from reference texts.

1. Introduction – aircraft structures and materials
2. Introduction to theory of elasticity and energy methods
3. Analysis of simple trusses and pressure vessels
4. Analysis and design of thin-walled beams with solid, open thin-walled, and closed thin-walled cross-sections subject to
   a. axial loads
   b. torsion loads
   c. bending loads
   d. shear loads
5. Failure analysis of for isotropic materials
   a. Stress failure criteria for metals
   b. Fracture mechanics principle
   c. Fatigue failure of metallic structures
6. Elastic buckling of beam and plate elements

Student learning outcomes:

Students who successfully complete the course will demonstrate:

1. a working knowledge of airframe structures, their construction, loads and materials used
2. a good understanding of the fundamental equations of linear elasticity and their use to solve simple structural problems
3. an understanding of the physical and mathematical approximations made to derive solutions and their limitations
4. an ability to compute bending stresses and deflections of thin-walled beamlike structures with symmetric and asymmetric open or closed sections cross sections.
5. an ability to compute shear stresses and twist angles in torsion for solid, closed thin-walled, and open thin-walled sections.
6. an understanding of the flexural shear stresses in a beam, shear center and an ability to predict their locations.
7. a knowledge of different failure criterion and an ability to predict failure given the stress state of a body, and use it design practice.
8. an understanding of concepts relating to fatigue and fracture of structures and ability to implement this understanding in design practice.
9. an ability to calculate the critical load for buckling of a beam and plate structures.
10.

Grading: Grades will be determined using these weights:

1. Homework assignments, projects and in class quizzes 30%,
2. Two in-semester exams 40%,
3. Final exam and/or project 30%,

Grades are based on scale (e.g., A=91+, B+=86+, B=81+,C+=76+, C=71+, D+=66+, D=61+). The letter grade assignment will follow the following definition provided in the SDSU student catalog under university policies:

A -outstanding achievement; available only for the highest accomplishment (4 points)
B - praiseworthy performance; definitely above average (3 points)
C - average; awarded for satisfactory performance (2 points)
D - minimally passing; less than the typical undergraduate achievement (1 point)
F – failing (0 points)

Plusses and minuses will be used to designate intermediate performance.

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Homework: Homework assignments will consist of problem solving exercises, design application exercises, small written papers and presentations. The problem solving exercises will use textbook problems designed to help students understand basic concepts in structural analysis. The design problems are highly simplified versions of real life problems that are less well defined than textbook problems and require the students to develop a formal problem statement, a solution to the problem, and description of the limitation and scope of the solution proposed.

You may discuss homework problems with your classmates, but work turned in for grading must be your own. If you discuss the homework assignment with your study group, acknowledge the extent to which you received help. Verbatim copying of homework solutions from others will be considered as academic cheating. Homework assignments are also intended to develop written communication skills. Provide detail descriptions of the solution process with all homework assignments. The clarity, completeness of the solution is as important as the correctness. The criterion you should apply to judge clarity is the following: Five years from now, you should be able to pick up the homework, understand exactly what was done, and be able to verify its correctness with a minimum investment of time without having to refer to the textbook. This also allows the instructor and grader provide you with meaningful feedback.

Projects: During the semester you will be assigned assignments and small projects that will be carried out as a teams comprising of 2 or 3 students. The project will require the design of some aerospace structural component. These projects will require you perform analysis and design using material presented from the course. The design reports must include a detailed documentation of your analysis calculations, details of the analysis, a final design, limitations of the design and recommendations for further improvement. A single report will be submitted by the team and will represent the effort of the group.

In-Term Exams: In-class exams will be closed book and notes, except for one 8.5"x11" page of handwritten notes.

Final Exam: The final exam will be comprehensive and will be closed book and closed notes. A final project may be assigned as part or in lieu of the final exam.

Academic honesty: All students admitted to SDSU have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. Academic honesty requires that you acknowledge any source of information that you have used for materials submitted for credit.

Software Use All faculty, staff and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Miscellaneous Only University approved excuses for absences will be accepted. Each student will be responsible for knowledge of all scheduling and announcements made in class.