San José State University

Department of Aerospace Engineering

AE251, Structural Vibrations for Aerospace Applications, Spring 2021

Course and Contact Information

Instructor:	Dr. Maria Chierichetti
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Office Hours:	TBA
Class Days/Time:	TBA
Classroom:	TBA

Course Format

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on on Canvas Learning Management System course login website at http://sjsu.instructure.com. You are responsible for regularly checking with the messaging system through MySJSU on Spartan App Portal http://one.sjsu.edu (or other communication system as indicated by the instructor) to learn of any updates.

Course Description

This class introduces the analysis of vibrations of flexible bodies encountered as elements of aircraft and space structures. Topics include: free and forced vibrations of single- and multi-degree of freedom systems, simplified analysis of vibrations induced by flutter, free and forced vibrations of beams in bending and torsion, signal processing techniques for time-varying signals, forced and ground vibration testing of aerospace components, finite element analysis for dynamic systems, spacecraft and aircraft dynamic design loads.

Course Goals

1. To review vibrations of single- and multi-degree-of-freedom systems
2. To review the design principles of vibration absorbers for aircraft and space elements
3. To become familiar with analytical models to analyze the vibrations of one-dimensional aerospace components
4. To show the application of numerical and experimental techniques for vibration testing and modal analysis
5. To analyze the dynamic loads to which aircraft and space components are subject to
6. To provide a fundamental knowledge of flutter

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

1. Derive equations of motion of aerospace components modeled with multi degree of freedom lumped parameter systems, and compute the free- and forced-vibration response

2. Design a simplified system for vibration suppression for aeronautical (i.e. landing gear, control surfaces) and space components (i.e. deployable panels)
3. Determine the equation of motion of a one-dimensional flexible system (i.e. aircraft wing, helicopter rotor blade, solar panel, deployable boom, ….) and compute its modal properties
4. Model a flexible system using finite element analysis and correlate to experimental measurements
5. Analyze the design dynamic loads of aerospace structures
6. Design experiments for vibration testing of aerospace components
7. Analyze situations in which aerodynamic loads and vibrations create an unstable system
8. Compute the free- and forced-response of an aerospace component
9. Analyze and improve finite element models based on ground/forced vibration testing

Required Texts/Readings

Textbook

Engineering Vibrations, *D. J. Inman*, Pearson, 4th Edition, 2014 (recommended)

Other Readings

1. "Introduction to Structural Dynamics and Aeroelasticity", *D. H. Hodges, G. A. Pierce*, Cambridge University, 2nd Edition, 2011
2. Concepts and Applications of Finite Element Analysis, *R. D. Cook, D. S. Malkus, M E. Plesha, R J. Witt*, Wiley, 2001
3. Spacecraft Structures, *J. Wijker*, Springer, 2008

Course Requirements and Assignments

Grading for this class will be based on 6-7 homework assignments, 2-3 lab experiences (numerical and experimental), 2 midterms and a final.

"Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus."

Final Examination or Evaluation

The final examination will take place according to the final exam schedule of SJSU

Grading Information

The grading policy is described in the table below.

Grade	*Points*	*Percentage*
A plus	*960 to 1000*	*96 to 100%*
A	*930 to 959*	*93 to 95%*
A minus	*900 to 929*	*90 to 92%*
B plus	*860 to 899*	*86 to 89 %*
B	*830 to 859*	*83 to 85%*

Grade	*Points*	*Percentage*
B minus	*800 to 829*	*80 to 82%*
C plus	*760 to 799*	*76 to 79%*
C	*730 to 759*	*73 to 75%*
C minus	*700 to 729*	*70 to 72%*
D plus	*660 to 699*	*66 to 69%*
D	*630 to 659*	*63 to 65%*
D minus	*600 to 629*	*60 to 62%*

University Policies

Per University Policy S16-9 *(http://www.sjsu.edu/senate/docs/S16-9.pdf)*, relevant information to all courses, such as academic integrity, accommodations, dropping and adding, consent for recording of class, etc. is available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/".

The AE Program policies can be found at http://www.sjsu.edu/ae/programs/policies/

AE 251, Spring 2021, Course Schedule

Course Schedule

Week	Date	Topics, Readings, Assignments, Deadlines
1		Review of free vibrations of single degree of freedom systems
1		One-degree-of-freedom flutter
2		Free vibrations of multi-degree-of-freedom systems
2		Forced vibrations of multi-degree-of-freedom systems
3		Two-degree-of-freedom flutter
3		Design of vibration suppression systems
4		Design of vibration suppression systems
4		Signal processing and representation of time-varying signals (FFT & PSD)
5		Signal processing and representation of time-varying signals (FFT & PSD)
5		Review
6		Midterm
6		Spacecraft design loads (dynamic and shock loads)
7		Aircraft design loads (ground vibrations, buffeting, flutter)
7		Uniform beam torsional dynamics (modes and frequencies)
8		Uniform beam torsional dynamics (forced response)
8		Uniform beam bending dynamics (modes and frequencies)

Week	Date	Topics, Readings, Assignments, Deadlines
9		Uniform beam bending dynamics (forced response)
9		Vibrations of beams in coupled bending and torsion
10		Flutter analysis for a uniform wing
10		Dynamic testing: hardware
11		Dynamic testing: harmonic and random excitations
11		Modal analysis in dynamic testing: mode shapes and natural frequency extraction
12		Review
12		Midterm
13		Finite element modeling in dynamics: stiffness matrix for beams
13		Finite element modeling in dynamics: mass and damping matrices
14		Finite element modeling in dynamics: computing modal parameters
14		Finite element modeling in dynamics: forced response
15		Finite element modeling in dynamics: model reduction methods
15		Ground-vibration tests of full airplanes
16		Review
Final Exam		TBA