

ASEN 5022: Dynamics of Aerospace Structures

Spring 2024

Class meetings: Tue/Thu 1:00 PM - 2:15 PM in AERO - N250

Class Mode: Hybrid

Instructor:

Prof. Sanghamitra Neogi

Office: AERO 357

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Course Objectives:

The Dynamics of Aerospace Structures encompasses the application of concepts covered in undergraduate dynamics, structures, and mathematics to analyze the dynamics of aerospace structural components. The course incorporates methods of dynamic analysis, vibrational characteristics, vibration measurements, and dynamic stability.

Additionally, this course has a project component through which the student will get to

1. Apply theoretical concepts learnt during the course on a specific example,
2. Practice developing models with increased complexity,
3. Learn to distinguish models according to their strengths and weaknesses, and
4. Critically analyze predictions from models incorporating different levels of approximations.

Logistics:

A. Office hours

2:30 PM - 3:30 PM Tue/Thu, otherwise by appointment.

B. Prerequisites

ASEN 5012, 5227 or equivalent. Recommended: MATH 313. Students are expected to be familiar with energy methods from an undergraduate dynamics course.

C. Class Time

There are two 75-mins meetings per week. The time will include formal lecturing and group work presentations. You are responsible for all material discussed in class, whether you attended or not. Class schedule is posted on Canvas, subject to change. There will be a set of videos that you will be required to watch, details will be shared during lecture.

D. Website

Course materials are available on Canvas.

E. Reading Material

The textbook for the course will be *Mechanical Vibrations: Theory And Application To Structural Dynamics*, M. Géradin and D. Rixen, 3rd edition. The following book may be useful for reference:

- *Principles and Techniques of Vibrations*, L. Meirovitch and
- *Fundamentals of Structural Dynamics*, R. R. Craig and A. J. Kurdila, 2nd Edition.

F. Grades

Homework (40%), two mid-term exams (30%), and project (30%).

(a) Homework assignments: 40%

Homework will be due at 8 PM on Fridays and should be submitted to Canvas. Please do not email the files to the instructor. Please put all files (code, text documents, scanned files) into one zip file with the naming scheme (last- name)HW(homework number).zip. For example, neogiHW4.zip. Homework submitted by midnight of the day it is due will be penalized 25%. Homework submitted by 8 AM the day after it is due will be penalized 50%. Homework submitted after that time will result in a grade of zero.

(b) Project presentations and reports: 30%

This is a team-based activity and it will require the students to form a team with at least two members. Every team will receive a group grade. In addition, individual grades will be assigned based on team-peer-evaluation and instructor's evaluation of each member's contribution to the overall project progress. The objective of this activity is to train students to apply theoretical concepts learnt during the course on a specific problem, chosen by the team. There will be in-class project presentations to update progress of the project. There will be a final cumulative project presentation and a 5-page project report due at the end of the semester. The students can insert additional pages as Appendix, if necessary. However, the main narrative must fit within 5 pages.

Any grading disputes will be handled by the instructor. Any request for a grade change should be made to the instructor, in writing, within one week after the graded work is returned. Your entire submission will be subject to regrading. Students are advised to read and adhere to the Honor Code at the University of Colorado at Boulder.

(c) Exam dates (tentative):

- **Mid-term Exam 1:** Thursday, February 29
- **Mid-term Exam 2:** Thursday, April 18
- **Final Project Presentations:** Saturday, May 4, 1:30 PM - 4:00 PM

Course content:

1. Review of dynamics of single-degree-of-freedom systems
2. Analytical dynamics of discrete systems
 - (a) Principle of virtual work
 - (b) Hamilton's principle for conservative systems
 - (c) Lagrange equations of motion
3. Undamped vibration of n-degree-of-freedom systems
 - (a) Linear vibration about an equilibrium configuration
 - (b) Normal modes of vibration
 - (c) Free vibration and analysis under forced harmonic and external loadings
4. Damped vibration of n-degree-of-freedom systems
 - (a) Normal eigensolutions
 - (b) Forced harmonic response for lightly-damped systems
 - (c) State-space formulation of viscously damped systems
5. Dynamics of continuous systems

- (a) Formulation of 1D continuous systems
- (b) Continuous eigenproblem
- 6. Numerical methods in dynamical systems
 - (a) Displacement, Rayleigh-Ritz, and Finite Element methods
 - (b) Direct time integration methods
 - (c) Numerical solution of eigenvalue problems

SYLLABUS STATEMENTS

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy.

For more information, see the [classroom behavior policy](#), the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

Requirements for Infectious Disease

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all applicable campus policies and public health guidelines to reduce the risk of spreading infectious diseases. If public health conditions require, the university may also invoke related requirements for student conduct and disability accommodation that will apply to this class.

If you feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the [guidance of the Centers for Disease Control and Prevention \(CDC\) for isolation and testing](#). If you have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home but should follow the [guidance of the CDC for masking and testing](#).

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

If you have a required medical isolation for which you require adjustment, please inform the instructor as soon as possible about absence due to illness, injury, or medical isolation. Because of FERPA student privacy laws, we do not require students to state the nature of their illness when alerting. We do not require “doctor’s notes” for classes missed due to illness; campus health services no longer provide “doctor’s notes” or appointment verifications.

Preferred Student Names and Pronouns

CU Boulder recognizes that students’ legal information doesn’t always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors’ class rosters. In the absence of such updates, the name that appears on the class roster is the student’s legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the [Honor Code](#). Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: honor@colorado.edu, 303-492-5550. Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit [Honor Code](#) for more information on the academic integrity policy.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits [protected-class](#) discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, [reporting options](#), and [support resources](#) can be found on the [OIEC website](#).

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the [Don't Ignore It page](#).

Religious Accommodations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, please submit your request to your faculty member **beginning of the semester** so that your needs can be addressed.

See the [campus policy regarding religious observances](#) for full details.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact [Counseling and Psychiatric Services \(CAPS\)](#) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through [Academic Live Care](#). The Academic Live Care site also provides information about additional wellness services on campus that are available to students.