

ASEN 5022: Dynamics of Aerospace Structures

Spring 2022

Class meetings: Tue/Thu 1:00 PM - 2:15 PM in AERO - N240

Class Mode: Hybrid

Instructor:

Prof. Sanghamitra Neogi

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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 major 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

Remote mode: 10:00 AM - 11:00 AM Wed and Fri, otherwise by appointment.

In-person mode: 2:30 PM - 3:30 PM Tue and 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.

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

(a) Homework assignments: 30%

Homework will be due at 8 PM and should be submitted to Canvas. 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: 40%

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 multiple in-class project presentations to update progress of the project throughout the semester. 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 24
- **Mid-term Exam 2:** Thursday, April 7
- **Final Project Presentations:** Saturday, April 30, 1:30 PM - 4:00 PM or before.

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

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail 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 policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

REQUIREMENTS FOR COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu).

ACCOMMODATION FOR DISABILITIES

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.

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 academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, 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 the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, [reporting options](#), and the support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

RELIGIOUS HOLIDAYS

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. 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.