

**Smead Department of Aerospace Engineering Sciences  
University of Colorado Boulder**

**ASEN 3112 – Structures  
Spring 2021**

*Last updated January 19, 2021*

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Office Hours\*: Mondays 3:00-4:00 pm

\*To discuss personal matters, students may request a one-to-one meeting with one of the instructors

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**TA/TF Office Hours (Zoom):** Mondays 4:00-5:00 pm  
Thursdays 4:00-5:00 pm  
Fridays 4:00-5:00 pm

**Lectures:** M and W: 12:50–2:05 pm via Zoom

*Note: For the first lecture, on Friday 1/15/2021, use: Zoom Link*

**Recitations & Labs:** Section 012 W: 3:00 – 4:50 pm, AERO 141 (PILOT)

**Zoom Link:**

**Meeting ID:**

Section 013 W: 8:30 – 10:20 am, AERO 141 (PILOT)

**Zoom Link:**

Section 014 W: 3:00 – 4:50 pm, AERO 120 (Aero Auditorium)

**Zoom Link:**

**Meeting ID:**

**Class Web Sites:** Canvas, <https://canvas.colorado.edu> → ASEN3112  
Gradescope, <http://gradescope.com>

**Class e-mail list:** Through Canvas only

**Texts:** Lecture notes are posted on Canvas

**Prerequisites:** ASEN 2001-2003-2004 and APPM 2360, with grade of C or better in each.

**Course Objectives:** The main objective of the course is to introduce modern structural analysis techniques based on understanding of the development of internal forces, stresses and deformations. These are essential to the design and verification of advanced aerospace structures and systems. The course offers an introduction to matrix and finite-element methods for skeletal (truss and frame) structures, as well as to fundamental concepts in mechanical vibrations, structural dynamics, and structural stability.

### Major Course Topics and Schedule:

Week	Topic
1	The concept of stress
2	The concept of strain, Elastic behavior of materials
3	Plane stress, Torsion I
4	Torsion II & III
5	Deformation of beams I & II, Energy methods I
6	<b>Exam I</b>
7	Energy methods I & II IV, Finite element method I
8	Energy methods III & IV
9	Finite-element method I & II, Structural dynamics and vibration I
10	Finite-element method III & IV
11**	Structural dynamics and vibration I & II
12	<b>Exam II</b> , Structural dynamics and vibration III
13	Structural dynamics and vibration IV & V
14	Stability of structures I & II
15	Stability of structures III, <b>Exam III</b>

\*\*No homework will be assigned this week; recitation/lab sessions will be conducted online

### **Course Work:**

Coursework consists of reading assignments, homework, recitations, experimental/computer labs, three midterm exams and one final exam. Attendance to recitation is expected; **attendance to labs is mandatory**. Exams cover all material including lectures, recitations, laboratory work, and homework.

The delivery mode of the different components of the course work is detailed in below in Section **Course Delivery Modes**, posted on Canvas.

Recitations: Recitations are offered on Wednesdays in the locations mentioned above, as well as on Zoom for students who prefer this option. Each section is 1 hour 50 min each. The main objective is to review material covered during the week, especially those that are helpful for the currently assigned homework and labs. Recitations may also include additional exercise material, not covered in class, useful for midterm exam preparation. Students will work with the help of an instructor and TA/TFs through practice problems. The solutions to the practice problems will be discussed as part of recitations. Recitations also provide students with the opportunity to discuss questions with the instructor and the TA/TFs, in addition to office hours.

Reading Assignments: Reading assignments are to be completed before the lecture/discussion. The lecture/discussions should help to clarify and supplement what students have read.

Homework: Homework assignments are given most weeks and are due as specified in the assignment (typically Friday at 11:59 pm MST). No homework assignments are due in the week of midterm exams. Assignments generally cover 3 to 5 problems and are designed to help students become proficient in a subject. Before doing any homework, students should read the posted lectures and try to follow worked-out examples. This should give the student an idea of the principles involved and the solution method. Homework problems may be also discussed in the recitation prior to the due date.

Written work should be neat and readable with adequate space and margins. Messy work will be returned ungraded and a zero-score recorded. The main and essential steps of the solution approach need to be shown; failing to do so will result in a lower score. The final result needs to be indicated by an arrow, underline, or box. Multiple answers when one is required will be counted as incorrect. Copying material from any resource (including solutions manuals) and submitting it as one's own are considered plagiarism and are an Honor Code violation.

Labs: The four experimental labs are carried out in groups of about six students. The groups are created randomly among students of the same lab section. As the first step of working on lab assignments, students will watch videos of lab setup and data taking process in an online mode. Experimental data will be provided to students.

Computer Use: Several assignments and labs may require computer access and basic programming skills in languages such as MATLAB. As part of the introduction to finite-element methods the use of the commercial FEM package ANSYS is taught for the computer component of Lab 2. Students can either download these software packages to their personal computers, using campus or free student licenses. Access to virtual desktops will also be provided. Detailed information will be provided with homework and lab assignments.

## Grading Guidelines:

Group work: *	4 Lab reports	25% (= 5% + 10% + 5% + 5%)
Individual:	Homework	15%
	3 Midterm Exams	40% (= 10% + 15% + 15%)
	Final Exam	<u>20%</u>
		100%

\*Group work only counts toward final grade if the total individual grade is C or better. If the individual grade is below C, the final grade equals the total individual grade.

If the score of any of the 3 midterm exams is lower than the score of the final exam, the midterm grade is dropped, and the weighting of the final is increased by adding 10% (or 15%) for each dropped midterm. For example, if Midterm 1 is dropped, Midterms 2 and 3 will each weigh 15%, and the final exam will weigh 30%.

### Notes:

- Each homework assignment includes a set of several problems. The assignment is partially graded for completeness (20 pts), while one randomly selected problem is graded in detail for technical content and presentation (30 pts). Thus, the final score for each homework set is out of a total of 50 pts and computed based upon the numeric breakdown below:

$$HW \frac{Score}{50} = 30pts (Rand. Problem) + 20pts \times \frac{\# of Remaining Problems Completed}{\# of Remaining Problems in Set}$$

Solutions for all homework problems are posted on Canvas after the due date. The homework assignments with the two lowest scores are dropped. Homework needs to be submitted electronically through Gradescope; see information below. No hard copies will be accepted, nor will late homework be accepted under any circumstances. Computer or internet issues are not an acceptable excuses for missing the homework deadline.

- Midterms cover material discussed in the weeks prior to the exam. They provide a gauge to determine what an individual student has learned. The midterm exams are given remotely only and need to be taken during lecture. All midterm exams are open-book, i.e. students can use lecture notes and slides, as well as solutions to homework, recitation and practice problems. No makeup exams will be offered. However, the use of the internet for searching for information during exams is disallowed. Exam solutions need to be uploaded to Gradescope; see information below.
- The final exam spans the entire course but with additional emphasis on material covered since the third midterm. The final exam needs to be taken during the time assigned by the registrar's office. Exam solutions need to be uploaded to Gradescope; see information below.
- All your scores and grades will be posted on Canvas and need to be checked within **2 weeks** after they are posted; requests to change a score need to be made within this period. These requests must be made in email to **both** instructors. The subject line of the email should read:

**ASEN 3112 - Request for score change for <exam/lab/homework> <Id>**

- Graded homework, lab reports, midterm exams, and the final exam are returned via Gradescope; see information below. Students should check the assignment for grading correctness and request a change of score via Gradescope if incorrect grading is found. If indeed the grading was incorrect, the score on CANVAS will then be updated by the instructors and TA/TFs. No further request and email is needed.
- The instruction team can make minor changes to the above distribution of weight for each assignment based on variations in assignments.
- About Gradescope: Students will receive an email to sign up. Students will need to upload their assignment. In case of hand-written assignments, students can use a smartphone or use scanners at the CU library. Should a student not have access to either, please, contact the instructors within the first two weeks of the semester. Instructions on how to upload assignments can be found at [help.gradescope.com](http://help.gradescope.com).

Instructions on uploading assignments can be found at:

[https://www.youtube.com/watch?v=KMPoby5g\\_nE](https://www.youtube.com/watch?v=KMPoby5g_nE)

Instructions on viewing scores and feedback after an assignment is graded can be found at:

<https://www.youtube.com/watch?app=desktop&v=TOHCKI12mh0>

### Letter Grading Scheme:

The exact letter grading scheme used in the course will be determined at the end of the semester. However, grade cutoffs will not be moved higher than they are in the following scheme:

Letter	Grade Percent Grade	4.00 Scale
A	93.00 – 100.00	4.00
A-	90.00 – 92.99	3.67
B+	87.00 – 89.99	3.33
B	83.00 – 86.99	3.00
B-	80.00 – 82.99	2.67
C+	77.00 – 79.99	2.33
C	73.00 – 76.99	2.00
C-	70.00 – 72.99	1.67
D+	67.00 – 69.00	1.33
D	63.00 – 66.99	1.00
F	Below 63.00	0.00

### Exam Times and Locations:

- Midterm 1: Monday, February 15th, during lecture time
- Midterm 2: Monday, March 29th, during lecture time
- Midterm 3: Wednesday, April 21st, during lecture time
- Final exam: Monday, May 3rd, 1:30–4 p.m.

## Course Delivery Modes (**revised 1/15/2021**):

**Definitions** (in accordance with Department and registrar's office definitions):

- In-Person (Synchronous): activity in person on campus on scheduled days and times.
- Remote (Synchronous): activity via Zoom or other real-time platform on scheduled days and times; students will need to participate in activity or complete assignment at a specified time.
- Online (Asynchronous): activity via lecture capture or Canvas online; students can participate when it is convenient for them within a specified time window.

**Lectures:** Students chose to follow the lectures in a remote or online mode. If the online mode is chosen, Monday lectures should be watched before following Wednesday lecture and Wednesday lectures should be watched before following Monday. Exams will take place during scheduled lectures; **the exams are administered in a remote-mode only.**

**Labs:** The lab assignments will be introduced remotely during scheduled lab sessions (to be announced). Students can follow the introduction in a remote mode or watch a recording of the introduction in an online mode. After an assignment has been introduced, students should watch an online video of the experimental setup and the data taking process. **Students will work in groups on lab assignments in a remote style only.** Students can ask questions about lab assignments in-person (during following recitation sessions), remotely via Zoom during recitations, or remotely via Zoom during office hours.

**Recitations:** Students can choose to work on practice problems either in-person, in a remote mode, or an online mode. Students choosing the in-person mode will have to attend the recitation/lab session for which they are registered; all health guidelines and rules need to be strictly followed (see also item 7 under **Course Policies and Procedures**)<sup>+</sup>. The recitations will be recorded and posted on Canvas. During recitations, students using an in-person or remote mode can ask questions about practice and homework problems and lab assignments.

<sup>+</sup>While not required, it is recommended that students bring a laptop, tablet, or a smartphone to recitations such that they can project their solutions to screens in the lecture room, facilitating the discussion with the instructor and teaching assistants (TA). If an in-person mode turns out to be impractical for various reasons (health concerns, hampers group work and interaction with instructors and TAs), the instructors reserve the right to cancel the in-person option.

## Course Policies and Procedures:

1. The instructors will be committed to reply to email questions only in business hours, i.e. Monday through Friday, 8:00 am – 5:00 pm. Emails received 24 hours or less before the exams or any due dates are not guaranteed to be responded to.
2. The instructors may make changes to the weekly course schedule based on occurring events that require different dispositions. The instructors will give sufficient advanced notice through announcements in class and posting on Canvas. Changes to this syllabus and assignments may be announced at any time during class periods. The instructors will post the current syllabus and assignments on Canvas. Both are dated in the footnote.
3. This course exclusively uses Canvas to send out announcements, to provide daily/weekly comments to students on class activities, and to provide general information about course assignments. It is strongly recommended that all students setup their Canvas account such that they receive automatically a notification about new announcements and updates to the Canvas course page.

4. All written assignments (homework, midterm exams, lab reports and the final exam) need to be uploaded to Gradescope (<https://www.gradescope.com/>). Students should create an account on Gradescope using the CU Boulder email address. Lecture and lab quizzes are administered directly via Canvas.
5. No makeup homework and makeup exams will be offered. A zero-score is recorded for each missed homework and exam. Note that the two homework assignments with the lowest scores are dropped. If the score of a midterm is lower than the one of the final, the midterm is automatically dropped and the weighting on the final is increased by 10%.
6. 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 Code of Conduct](#).
7. As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:
  - maintain 6-foot distancing when possible,
  - wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
  - clean local work area,
  - practice hand hygiene,
  - follow public health orders, and
  - if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

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 policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

Before returning to campus, all students must complete the [COVID-19 Student Health and Expectations Course](#). Before coming on to campus each day, all students are required to complete a [Daily Health Form](#).

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the [Health Questionnaire and Illness Reporting Form](#) remotely. In this class, if you are sick or quarantined, please, alert the instructors about your absence due to illness or quarantine. Please, note there is no need to state the nature of their illness.

8. 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](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

9. 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.
10. All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: 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](mailto: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 at the [Honor Code Office website](#).
11. The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder 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 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 [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when 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 options for reporting and support resources.

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, students must let the instructors know of any such conflicts within the first two weeks of the semester so that reasonable arrangements can be worked out.

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

### **Final Comments**

The grading scheme in this course is not assigned to reward or punish. It is designed to indicate the student's level of competency compared to the standards set by the AES faculty. Does the student meet the minimum level of competency? Does the student exceed the minimum? Is the student below the minimum? This should be indicated by the final grade. The instructors are professionals and it is their job to set and maintain standards. The instructors are expected to use their education, experience, and interactions with industry, government laboratories, others in academe, etc., to determine the content and level of these standards. Because the CU Aerospace Engineering program is accredited by ABET (Accreditation Board for Engineering and Technology), the AES curriculum meets that board's



requirements. As with any other professionals (engineers, doctors, lawyers, etc.) the students must trust that the instructors know what they are doing and that they are obliged to uphold standards.

The final grade indicates the student's readiness to continue to the next level of courses. Meeting the minimum requirements indicates that the student is prepared to continue at least at the minimum level required for the next in the sequence of courses. Exceeding the minimum means the student is ready to enter the next course and that the student has mastery of material beyond the minimum, i.e., the student shows acceptable level of proficiency.