ASEN 5012: Mechanics of Aerospace Structures

Fall 2019

Class meetings: MWF 3:30 – 4:20 PM in AERO 114

Instructor:

Kurt Maute
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Office hours: Th 3:00 – 4:00 in AERO 303*

Teaching Assistant:

Mohammad Mokhtarzadeh Khanegahi
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Office hours: F 1:00 – 2:00 in AERO 303*

* unless otherwise announced in class or via CANVAS announcements.

Prerequisite:

ASEN: APPM 2360 and ASEN 2001, 2003, and 3112, or equivalent

References:

1. W. M. Lai, D. Rubin, and E. Krempl, "Introduction to continuum mechanics", 4th ed., Butterworth-Heinemann/Elsevier, Amsterdam, 2010*,+

2. J. N. Reddy, "An Introduction to Continuum Mechanics", Cambridge University Press, 2013*

3. A. F. Bower, "Applied Mechanics of Solids", Taylor and Francis, 2009*

4. A. P. Boresi and K. P. Chong, "Elasticity in Engineering Mechanics", 2nd edition, Wiley Interscience Publications, New York, 2000*,+

5. Y. C. Fung and P. Tong, "Classical and computational solid mechanics (Advanced series in engineering sciences)", World Scientific Publishing, Singapore, 2001*

6. M. E. Gurtin, "An introduction to continuum mechanics (Mathematics In Science and Engineering)", Academic Press, 2003+

7. Y. C. Fung, "A first course in continuum mechanics", Englewood Cliffs, N.J. : Prentice Hall, 1994

8. L. E. Malvern, "Introduction to the mechanics of a continuous medium", Englewood Cliffs, N.J. : Prentice-Hall, 1969

* recommended; + available electronically through CU library

Grading:

Homework (20%)**, two mid-term exams (20%+20%), and an in-class final exam (40%). The homework assignment with the lowest score will be dropped. If the score of any of the two midterm exams is lower than the score of the final exam, the midterm is dropped, and the weighting of the final is increased from 40% to 60% (or 80% if both midterms score lower than the final).

No make-up homework assignments and make-up exams will be offered. If a student does not turn in a homework assignment (in time) or does not take an exam, a zero score will be assigned. Please, see policy on grading homework assignments and exams. A make-up final will be offered if the student provides a valid justification for missing the final.

** Groups of up to three students can work together on homework assignments. Homework will be graded partially for completeness and partially for correctness, i.e. only a randomly chosen subset of questions will be graded for technical correctness and presentation; solutions for all homework problems will be posted.

Notes:

- All communication outside the class room will be done via the course Canvas website and email. It is the student's responsibility to check regularly for updates to the Canvas website. It is strongly recommended to activate the option in Canvas to receive automatic notifications whenever the course website is updated.
- Class participation and discussions are highly recommended.
- All homework needs to be turned in prior to class the day the homework is due (usually Fridays). Only one solution per homework group needs to be turned in.
- No late homework will be accepted.
- Work independently through your homework and discuss it with the members of your homework group and instructor if you have questions.

Exam dates:

- **Mid-term Exam 1:** Friday, October 4, 2019
- **Mid-term Exam 2:** Friday, November 15, 2019
- **Final Exam (comprehensive):** Wednesday, December 18, 7:30 PM 10:00 PM.

Course content:

1. Scalar, Vector, and Tensor Algebra
   (a) Concept of scalars, vectors, and tensors
   (b) Some basic operations of scalars, vectors, and tensors
2. Stress and Strain Tensors
   (a) Traction and stress tensor
   (b) Equation of static equilibrium
   (c) Linear and nonlinear kinematics, finite deformation, strain tensor
   (d) Compatibility of strain fields
   (e) Plane stress and plane strain
   (f) Transformation of stress and strain tensor
   (g) Stress invariants and stress deviations
3. Constitutive Equations

   (a) Classification of materials
   (b) General Hooke's law
   (c) Concept of hyperelasticity

4. Conservation Laws
   (a) Material derivatives
   (b) Equations of continuity
   (c) Equations of motion

5. Linear Elasticity
   (a) Governing equations and uniqueness of boundary value problems
   (b) Plane stress and plane strain models
   (c) Saint Venant's theory of torsion
   (d) Airy stress function in Cartesian coordinates

6. Energy Theorems and Variational Methods
   (a) Principle of virtual displacement, strain energy, complementary energy, potential energy
   (b) Variational method

7. Nonlinear Elasticity
   (a) Finite deformation
   (b) Principle of virtual work applied to geometrically nonlinear problems
   (c) Elastic buckling

8. Advanced Topics ***
   (a) Elasto-Plasticity and models for material failure
   (b) Thermo- and viscoelasticity
   (c) Method of Lagrange multipliers

*** covered only if time permits

University policies:

Policy Regarding 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 or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website.

Policy Regarding Classroom Behavior - Students and faculty each have responsibility for maintaining an appropriate learning environment. 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. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the

semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Policy Regarding University 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 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); 303-492-5550). Students who are 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.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation - The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct intimate partner abuse (including dating or domestic violence), stalking, 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. 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, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Policy Regarding Religious Observance - 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 instructor know of any such conflicts within the first two weeks of the semester so that reasonable arrangements can be worked out. See campus policy regarding religious observances for full details.