CARLETON UNIVERSITY
Department of Civil and Environmental Engineering

Course Outline
CIVE 5101 – Solid Mechanics Fall 2026

Time: **Tuesday 6:05-8:55 pm**
Place: ***Please refer to the Public Class Schedule for the most recent information**

Instructor: **Khoo, H.A.** **Room 3364 ME**
Phone 520-2600 Ext. 5798 **heng.khoo@carleton.ca**
Office Hour: **To be determined**

1) Course description
Cartesion tensor notation; stresses and strains in a continuum; transformations, invariants; equations of motion; constitutive relations; generalized Hooke's Law, bounds for elastic constant: strain energy, superposition, uniqueness; formulation of plane stress and plane strain problems; energy principles, variational methods; plasticity

2) Objectives and Learning Outcomes:
Upon successful completion of this course, students will acquire general knowledge on continuum mechanics and theory of elasticity: tensors, stress, strain, Hooke's law, problems in linear elasticity, equilibrium formulations using energy, plasticity.

1. Know the properties and used of tensor in solid mechanics.
2. Learn about different definitions of stress, stress equilibrium, stress transformation, principal stresses and invariants
3. Understand the formulations of strain for small and large displacement (rotation), relative displacement and rotation, the relationship between strain and displacement (compatibility), strain transformation, principal strains and invariants
4. Learn about the relationship between stress and strain for linear elasticity (Hooke's law), various forms of linear elastic materials
5. Know displacement and stress formulations of differential equations for linear elastic problems. Understand the assumption and formulation of plane stress and plane strain problem, relationship between plane stress and plane strain, Airy stress function, and solving problems using stress function.
6. Know the formulation of equilibrium using energy; variational method, principle of virtual work, principle of complementary virtual work (force), Castigliano theorems and other theorems. Applications using various energy principles.
7. Understand plasticity for metal, kinematic and isotropic hardening, yield function, evolution of plastic strain

	Topic
1	Vectors and tensors (basic tools)
2	Stress: stress tensor, transformation, differential equations of equilibrium, principal stresses and invariants
3	Strain: strain – displacement equations, transformation, relative displacement and rotation
4	Constitutive equations for linear elasticity
5	Plane stress and plane strain problems in linear elasticity
6	Energy principles, variational methods, various equilibrium formulations using energy
7	Mathematical theory of plasticity
8	Torsion: St. Venant and warping (if time permitted)

Marking:

Assignments: 50%
Final Exam: 50%

The final exam is closed book. Formula sheet will be provided. No electronic device other than the calculator is allowed.

a) Missed Term work

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for alternate arrangements with the instructor and in all cases this must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult Section 9.4 of the University Calendar

b) Final Examination

i) Final exam is for evaluation purpose and will not be returned to students.
ii) Students who are unable to write the final examination because of a serious illness/emergency or other circumstance beyond their control may apply for accommodation by contacting the Registrar's office. Consult Section 9.3 of the University Calendar

c) Late Submission Policy

Assignment due date is strict. Late submissions of Assignments will be given zero. 10 % deduction if Assignments handed in that are not stapled.

Academic Dates

Students should be aware of the academic dates (e.g. last day for academic withdrawal) posted on the Registrar's office web site Calendar website.

Notes:

1. The instructor may modify the outline during the term as the course progresses.
2. All email correspondence has to originate from the Carleton email account. I will only response to the Carleton email account.
3. Copyright: The materials (including the course outline and any slides, posted notes, videos, labs, project, assignments, quizzes, exams and solutions) created for this course and posted on this web site are intended for personal use and may not be reproduced or redistributed or posted on any web site without prior written permission from the author(s).
   The partial notes supplied on the website are intended to serve as complement and not replacement to regular class attendance. The author does not guarantee these notes to be 100% error free. Every effort will be made to identify the error and correct it during class
4. **Safer Learning and Working Environment**

Carleton University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca, Ombuds Services - Carleton University or submit an anonymous human rights concern through this form.

5. **Academic Accommodation**)

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances, are outlined on the Academic Accommodations website (students.carleton.ca/course-outline)

6. Unauthorized Dissemination

As per Carleton's Academic Integrity Policy, Unauthorized Dissemination is a violation of the standards of academic integrity to publish, disseminate, or otherwise make available to a third-party instructional material where the instructor has explicitly prohibited their dissemination.

The materials (including the course outline, slides, posted notes, videos, labs, projects, assignments, quizzes, exams, and solutions) created for this course are intended for personal use only. They may not be reproduced, redistributed, or disseminated in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without written permission from the author(s), both during and after the semester.

7. **Academic Integrity and Plagiarism**

One of the main objectives of the Academic Integrity Policy is to ensure that **the work you submit is your own.** As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

You may discuss with others, but you are required to submit your own work for Homework. You may not complete the submitted work collaboratively. See the institutional policy on the academic integrity (https://carleton.ca/registrar/academic-integrity/)

8. **Generative Artificial Intelligence (GenAI)**

As our understanding of the uses of GenAI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of GenAI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

AI use in this course: Students may use AI tools for ideas, clarifying challenging concepts or getting started on projects. Some acceptable uses include:

Sounding board (e.g. generating essay topics with ChatGPT, using Microsoft Word's Smart Lookup or Copilot to find inspiration and related topics)

Creating outlines (e.g. using AI to structure an essay or presentation flow, using Microsoft Word's Outline View with AI suggestions)

Providing definitions or explanations of complex concepts (e.g. using AI to explain a difficult theory or to find relevant information)

Documenting use of AI: It is necessary to document your use of AI in this course, using the following guidelines:

Clearly identify and cite AI-generated text (e.g. "The following paragraph was generated by ChatGPT/Microsoft Word's Researcher tool/Copilot")
Review, edit and ensure accuracy and originality of final submissions
AI-generated content should not exceed X per cent (instructor to modify – we recommend no more than 30 per cent) of the total assignment length

Why have I adopted this policy? This policy supports the use of AI as a supplementary tool, helping students develop ideas and structure their work while emphasizing the importance of transparency and personal engagement with the content. AI can be used for inspiration and foundational support and can encourage students to critically assess and refine AI-generated material.

9. **Student Mental Health and Wellness**

As a university student you may experience a range of mental health challenges that can significantly impact your academic success and overall well-being. Carleton's **Wellness Services Navigator** is designed to help students connect with mental health and wellness resources.

Here is a list of on-campus and off-campus recourses:

a. Emergencies and Crisis
b. **Carleton's Wellness Desk**: Located at 204A MacOdrum Library, is a space for students to learn about resources, connect with our Wellness Coordinator, and decompress during stressful times of the year. You can pop into the Wellness Desk any time during its hours of operation – no appointments necessary! https://wellness.carleton.ca/mental-health/wellness-desk/
c. **Carleton's Care and Support Team**: The role of a Care and Support Team is to support students with any questions or concerns they may have relating to their academics, well-being, finances or any other challenges they may be experiencing.https://wellness.carleton.ca/mental-health/student-care-and-support-team/
d. **Carleton's Health and Counselling Services:** To book an appointment visit the CHR Connect App or contact the main clinic by calling 613-520-6674 ext. 2. If urgent, let the Patient Care Coordinator know or go in person to the main clinic (2500 Carleton Technology and Training Centre Building) and indicate that they are in crisis and need to speak to someone right away. https://wellness.carleton.ca/counselling/
e. **Carleton's Single Session Counselling:** To book an appointment visit the CHR Connect App. https://thconnect.telushealth.com/mobile-app-information/xz6lzGrv
f. **Residence Counselling and Wellness Service:** Counselling services specifically for students in residence. To book an appointment call 613-520-2600 ext. 8061. https://carleton.ca/health/residence-counselling/
g. **Carleton's Therapy Dogs:** Carleton's therapy dogs are around campus with their owners (who are Carleton University staff and faculty) to comfort and provide support to help you thrive as a university student. https://wellness.carleton.ca/mental-health/therapy-dogs/
h. **Good2Talk (1-866-925-5454):** Good2Talk is a free, confidential helpline providing professional counselling and information and referrals for mental health, addictions and well-being to post-secondary students in Ontario, 24/7/36 https://good2talk.ca/
i. **The Walk-In Counselling Clinic (off-campus community resource):** The Walk-in Counselling Clinic has offices in various locations across Ottawa and the greater

Champlain region that are open 7 days a week. Individuals will be assisted, with no appointment, on a first-come, first-serve basis during the Walk-in Counselling Clinic hours. The Walk-in Counselling Clinic **offers services in many languages** and is free and confidential. More information can be found at: https://walkincounselling.com/

j. **Distress Centre of Ottawa and Region**: Available 10am-11pm, 7 days/week, 365 days/year. **Distress Line:** 613-238-3311, **Crisis Line:** 613-722-6914 or 1-866-996-0991, **Text:** 343-306-5550. https://www.dcottawa.on.ca/

k. **Distress and Crisis Ontario**, Available for chat 2 pm – 2 am EST. https://www.dcontario.org/

l. **BounceBack Ontario (Toll-Free: 1-866-345-0224)** is a free skill-building program managed by the Canadian Mental Health Association (CMHA). It is designed to help adults and youth 15+ manage low mood, mild to moderate depression and anxiety, stress or worry. Delivered over the phone with a coach and through online videos, you will get access to tools that will support you on your path to mental wellness. https://bouncebackontario.ca/.

Some References:

1. Chou and Pagano: *Elasticity: Tensor, Dyadic and Engineering Approaches*
2. Timoshenko and Goodier: *Theory of Elasticity*
3. Fung: *Foundations of Solid Mechanics*
4. Sokolnikoff: *Mathematical Theory of Elasticity*
5. Wang: *Applied Elasticity*
6. Nadeau: *Introductory to Elasticity*
7. Jeffreys: *Cartesian Tensors*
8. Westergaard: *Theory of Elasticity and Plasticity*
9. Fung: *A First Course in Continuum Mechanics*
10. Hodge: *Continuum Mechanics*
11. Malvern: *Introduction to the Mechanics of a Continuous Medium*
12. Prager: *Introduction to Mechanics of Continua*
13. Spencer: *Continuum Mechanics*