Western University - Faculty of Engineering Department of Civil and Environmental Engineering

<u>CEE 2202a – Mechanics of Materials</u> <u>Course Outline Fall 2023</u>

Objectives:

This course introduces the fundamental principles used in the study of the engineering behaviour of structures and mechanical members subjected to slowly applied or steady state loading conditions. The general objectives are for the student to develop the ability to:

- Apply the knowledge of statics, properties of materials and basic mathematics to analyse the stress-strain behaviour of structural members subjected to slowly applied or steady state loads.
- Differentiate between various static loading conditions of simple structures and formulate progressive solutions to quantify their stress-strain behaviour.
- Work individually or function in a team to analyze the stress-strain behaviour of simple structural elements under combined loading conditions, to design simple beams to meet specific design needs and effectively communicate the results of this work in coherent and legible design calculations.
- Develop awareness of the applications of the skills and techniques introduced in this course in civil engineering practice.
- Recognize the need for life-long learning to keep abreast of new developments in the engineering practice and to improve one's design abilities to solve more complex contemporary engineering problems.

Calendar Copy:

Concept of stress and strain; axially loaded members; second moment of area; elastic torsion of circular shafts; bending and shearing stresses in beams; transformation of stress and strain; stresses in thin-walled pressure vessels; design of beams and introduction to beam deflection. Course Weight: 0.50.

<u>Pre-requisites:</u> Engineering Science 1022A/B/Y, NMM 1412A/B or the former Applied Mathematics 1412A/B.

Anti-requisites: MME 2202A/B.

Note: It is the **student's responsibility** to ensure that all Pre-requisite and Co-requisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Anti-requisite. The students may be dropped from the course or not given credit for the course towards their degree if they violate the Pre-requisite, Co-requisite or Anti-requisite conditions.

Contact Hours:

• <u>3 lecture hours/week</u>: Lectures will be delivered in-person. In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, affected course content will be delivered entirely online, either synchronously

(i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.

• <u>3 tutorial hours</u>: A 3-hour in-person tutorial session will be delivered each week. Student attendance of the tutorial is mandatory. Attendance marks will be given for each tutorial.

Instructor:

Hassan EL-Chabib, PhD, P. Eng., SEB 3029, <u>helchab2@uwo.ca</u>. Office hour: Wednesday, 11:00 am – 12:00 pm or by appointment

Textbook and Notes:

- R.C. Hibbeler, Mechanics of Materials, SI Units 10th Edition, Pearson Prentice Hall (purchase recommended).
- Course notes will be regularly posted on the OWL course website as needed. It is the student's responsibility to regularly check the course website and print notes if required.

<u>Units:</u>

SI units are used in lectures and examinations. Some problems and assignments may be in imperial units.

Specific Learning Objectives: At the completion of the course, students should be able to recognize and understand:

- 1. Concept of Stress:
 - a) Differentiate between normal, shearing and bearing stresses [PA1]
 - b) Analyse stresses in simple structures [PA2]
 - c) Identify the components of stress under general loading conditions [PA1]

2. Stress and Strain – Axial Loading:

- a) Determine stress-strain relationships under axial loading using Hooke's Law [PA1]
- b) Calculate deformations of axially loaded members [PA2]
- c) Identify and solve simple statically indeterminate problems [PA1]
- d) Analyse the effects of temperature changes in axial loading conditions [PA2]
- e) Assess multi-axial loading cases and use the generalised Hooke's Law [KB4]
- f) Determine the effect of shearing strain [PA1]
- g) Apply the stress and strain distribution (Saint-Venant's Principle) [PA2]

3. Torsion

- a) Define and calculate the polar moment of inertia [PA1]
- b) Compute deformations and stresses in a circular shaft [PA2]
- c) Analyse statically indeterminate shafts [KB4]
- d) Determine torsion stresses in thin-walled hollow shafts [PA2]

4. Pure Bending

- a) Define and calculate centroids and moments of inertia [PA1]
- b) Discuss the basic assumptions of the engineering bending theory [PA1]
- c) Compute deformations and stresses in symmetric members [PA2]

- d) Compute deformations due to transverse loading [PA2]
- 5. Transverse Loading
 - a) Calculate and graphically represent normal stress distributions [PA1]
 - b) Analyse problems of shear on a horizontal plane [PA2]
 - c) Compute and graphically represent the distribution of shearing stresses in beams [PA2]

6. Transformations of Stress and Strain

- a) Carryout transformation of plane stresses, define principal stresses and maximum shearing stresses and apply Mohr's circle for plane stress [PA2]
- b) Carryout transformation of plane strain, define principal strains and maximum shearing strains and apply Mohr's circle for plane strain **[PA2]**
- c) Analyse experimentally measured strain, discuss and interpret results [PA2]

7. Design of Beams

- a) Determine bending moments and shear force diagrams for a given span and loading [PA2]
- b) Define relations among load, shear and bending moment [PA2]
- c) Identify and compute principal stresses in beams [KB4]

8. Deflection of Beams (time permitting)

- a) Analyse the deformation of a beam under transverse loading [PA2]
- b) Analyse and design statically indeterminate beams [KB4]
- c) Apply superposition to assess deflections/stresses due to various load combinations [KB4]

General Learning Objectives

E=*Evaluate*, *T*=*Teach*, *I*=*Introduce*

Problem Analysis	Е	Team Work	Ι	Ethics and Equity	
Investigation	Т	Communication	Ι	Economics and Project Management	
Design	Ι	Professionalism	Ι	Life-Long Learning	
Engineering Tools	Ι	Impact on Society			

Evaluation:

The final course mark will be determined as follows:

Quizzes:	20%
Attendance/Participation:	10%
Mid-term exam:	30%
Final examination:	40%
Total:	100%

Note:

Students must pass the final examination to pass this course. Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less. Students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories, if applicable, cannot be resubmitted for grading by the student in subsequent years.

Quizzes and Examinations

- Two one-hour quizzes will be scheduled throughout the term during the tutorial period at the following dates: **September 28 and November 30**.
- Midterm Exam: 2 hour midterm exam is tentatively scheduled during the tutorial period on October 26.
- Final Exam: 3-hour final examination will be held during the final examination period

Quizzes and examinations will be closed book and only non programmable calculators are permitted. Students should consult the list of approved calculators posted outside the Civil and Environmental Engineering Department Office.

1. Missed Quiz or Midterm

The policy of the department of Civil and Environmental Engineering is that there will be **no make-up for missed quizzes or midterms**. For those that do legitimately miss a quiz or midterm and provide the required supporting documentation, the standard practice will be that the weight of the missed quiz/midterm will be reassigned to the final exam.

2. Weekly Assignments

Assignments will be given on a weekly basis and consist of two parts. *Part A* will be solved in class with the support of teaching assistants. *Part B* is assigned as **homework and should be solved individually**. A solution for **both parts A and B** will be posted on the course website. Students are highly encouraged to solve all assignment questions to do well in the course. Assignments will not be marked but their completion will be considered as attendance/participation.

3. Use of English:

In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work, except for the final examination, may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

- **4.** Academic Integrity: University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning. For more information on scholastic offenses, please see: http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf
- **5.** Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Accommodation and Accessibility:

• **Students with disabilities** are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf.

• **Religious Accommodation:** When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at https://multiculturalcalendar.com/ecal/index.php?s=c-univwo.

Conduct:

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Please turn off your cell phone before coming to a class, tutorial, quiz or exam. On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: http://www.uwo.ca/univsec/board/code.pdf

Sickness and Other Problems:

Students should immediately consult with the instructor if they have any problems that could affect their performance in the course. The student should seek advice from the instructor regarding how best to deal with the problem. Failure to notify the instructor immediately (or as soon as possible thereafter) will have a negative effect on any appeal. If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

• Assessments worth less than 10% of the overall course grade:

For work worth less than 10% of the total course grade, academic consideration might be granted by the instructor to students with a legitimate reason. If approved, student will be given extension to submit any missing work. In such a case where documentation is required, it can *only* be collected by the student's Dean's Office Academic Counselling unit.

• Assessments worth 10% or more of the overall course grade:

For work totaling 10% or more of the final course grade, students must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy at

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf.

The Student Medical Certificate is available at https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

Absences from Final Examinations

- If you must miss the Final Exam, please contact Western Engineering Undergraduate Services as soon as possible. They will assess your eligibility to write the Special Examination.
- You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

Note: missed work can *only* be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is **not** sufficient on its own.

Notice:

Students are responsible for regularly checking their email, course website (<u>https://owl.uwo.ca</u>) and notices posted outside the Civil and Environmental Engineering Department Office.

<u>Course breakdown</u>: Engineering Science = 100%.

The document "INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMINT ASSIGNMENTS AS SCHEDULED" is part of this course outline.