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

CEE 2221b - Structural Theory and Design - Course Outline 2023/24

This course focuses on identification, formulation, analysis and design of civil engineering structures. After completing the course, the students will be able to

- quickly calculate the reactions and draw the internal force diagrams for statically determinate two-dimensional structures based on equilibrium;
- identify the load path and tributary loading for surface loads on statically determinate three-dimensional structures;
- quickly calculate the deflections of statically determinate two-dimensional structures using the virtual work principle;
- quantitatively determine the influence lines for statically determinate structures and use the influence lines to calculate the internal forces and deflections of structures subjected to moving loads;
- distinguish working stress and limit states designs, and recognize different types of loads in structural designs;
- use the limit states design approach to either proportion structural steel members subjected to axial force, shear force and bending moment or to check the adequacy of such members;
- apply the force method to analyze statically indeterminate structures with two degrees of redundancy, and
- work individually and in groups to develop the capacities for critical thinking, problem solving, as well as communicating their work and ideas both in writing and in oral class discussions.
- recognize the need for life-long learning to keep abreast of the new advancements in the analysis, design and construction of engineering structures, and to enhance one's abilities as a civil engineer.

Calendar Copy:

A consolidation of the analysis and design of statically determinate structures, and an introduction to the analysis of indeterminate structures. Analysis and design of statically determinate beams and frames; bending of unsymmetric sections; virtual work and energy methods, introduction to indeterminate structural analysis.

Prerequisites:

CEE 2202A/B, CEE 2220A/B, AM 2270A/B

Corequisites:

None

Antirequisites:

None

Note: It is the student's responsibility to ensure that all Prerequisite and Corequisite 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 Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Contact Hours:

3 lecture hours/week

Lectures will be organized into learning modules, which students should review on a weekly basis. Review of lecture material and self-study should take approximately 6 hours per week.

2 tutorial hours/week

Attendance of the tutorial session is mandatory.

Instructor: Dr. Wenxing Zhou, P. Eng. E-mail: wzhou@eng.uwo.ca Office hour:

• TBA

• Students may also set up appointment for office hours with TAs

Administrative support: Ms. S. McKay, SEB3005

Textbook:

1. Structural Theory and Design – Lecture Notes, posted on OWL, required.

Other References:

Structural Analysis, A. Kassimali, CENGAGE Learning, 5th Edition, 2015, Purchase optional *Mechanics of Materials*, F.P. Beer and E.R. Johnston, Jr., 2nd Edition in SI Units, McGraw-Hill, 1992. Purchase optional *Structural Analysis*, R. C. Hibbler, Prentice Hall, 8th Edition, 2012. Purchase optional.

Units:

Both SI and Imperial unit systems may be used in lectures, tutorials and examinations.

Specific Learning Objectives [GA indicators – bold represents evaluated indicators]:

- 1. Analysis of Beams and Plane Frames (Weeks 1-3). At the end of this section, the students should be able to:
 - a. quickly and accurately develop the axial force, shear force and bending moment diagrams for statically determinate beams and plane frames [CS2, **KB4**]
 - b. qualitatively sketch the deflection curves of beams and frames [CS2, KB4];
 - c. apply the principle of superposition to calculate the beam and frame internal forces [CS2, KB4], and
 - d. apply the principle of symmetry to recognize and analyze symmetric plane structures [CS2, KB4].
- 2. Structural Idealization and Tributary Loading (Weeks 3-4). At the end of this section, the students should be able to:
 - a. recognize basic types of structure elements, structures, loads and load paths [KB3, KB4];
 - b. know the purposes of the Canadian national building code and various design codes [KB4].
 - c. know typical support conditions and joint connections, and convert supports and joints in actual structures into idealized support conditions and joint connections for performing structural analyses [KB3, KB4, PA1, PA2];
 - d. create idealized framing plans for simple structures [KB4, PA1, PA2], and
 - e. identify the load path and compute the tributary loading for vertically applied surface loads [KB4, PA1, PA2].
- 3. Introduction to Strength Design (Week 5). At the end of this section, the students should be able to:
 - a. know the basic formats of the work stress design and limit states design [PA2, PA3, D1], and
 - b. use the limit states design formulae to check the adequacy of steel members subjected to tension, bending and shear [KB3, PA2, PA3, D1].
- 4. *Deflection Calculation (Weeks 5-7).* At the end of this section, the students should be able to:
 - a. apply the Moment-area Method and Virtual Work Principle to calculate the deflections of statically determinate trusses, beams and two-dimensional frames [KB3, KB4, PA1, **PA2**, PA3], and
 - b. qualitatively sketch the deflection curves for trusses, beams and frames [KB4].
- 5. Influence Lines (Weeks 8-11). At the end of this section, the students should be able to:
 - a. quickly quantify the influence lines for statically determinate trusses and beams using a tabulated solution and Muller-Breslau Principle [KB4, PA1, PA2], and
 - b. apply the influence line to calculate the maximum internal forces in trusses and beams subjected to moving loads [KB4, PA1, PA2].

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- 6. Introduction to Indeterminate Structures (Week 12). At the end of this section, the students should be able to:
 - a. identify the three general sets of conditions for structural analyses: equilibrium, constitutive model and compatibility condition [KB4], and
 - b. use the force method to calculate the internal forces for statically indeterminate trusses, beams and frames with up to two degrees of redundancy [KB4, PA1, PA2].

The instructor may expand or revise material presented in the course as appropriate.

General Learning Objectives:

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

Evaluation:

The final mark will be determined as follows:

Participation	5%
Assignments	25%
Quizzes (2)	20%
Final Examination	<u>50%</u>
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 must turn in all assignments and achieve a passing grade, to pass this course. This condition may be waived by the instructor based on the student's specific circumstances.

Students who have failed this course previously 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 cannot be resubmitted.

1. **Quizzes and Examinations:**

Two one-hour quizzes will be held during tutorial hours. These quizzes are **tentatively** scheduled on **Friday**, **February 9**, **2024 and Friday**, **March 22**, **2024**. The classrooms for the quizzes will be announced in due course.

A three-hour written final examination will be held during the regular examination period.

The quiz and final exam are close book.

2. Assignments:

Weekly group assignments will be distributed in the tutorial periods. A tutorial group must submit one completed group assignment by the end of each tutorial period. Group membership will be assigned by the course instructor, and may be revised during the term. All members of a group must be present and work on the assignments during the tutorials. All group members whose names are on a submission will receive the same mark. **Bi-weekly individual assignments** will also be distributed in the tutorial. Each student must independently complete the individual assignment and submit the solution by the due date. **Late assignments will receive a mark of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants. Only a selection of questions from an individual assignment may be marked – the questions to be marked will not be determined or announced in advance. The intention is for students to complete the entire assignment to learn as much as possible the course materials.**

3. Use of English:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally poorly written work with the exception of 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.

Cheating:

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

Attendance:

Any student who, in the opinion of the instructor, has not engaged sufficiently in 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:

Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: <u>Academic Accommodation for Students with Disabilities</u>.

Academic Consideration for Student Absence

Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are *not* met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation. Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.

For Western University policy on Consideration for Student Absence, see

Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs and for the Student Medical Certificate (SMC), see: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

Religious Accommodation

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the <u>Western Multicultural Calendar</u>.

Use of Recordings:

All of the remote learning sessions for this course will be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals under special circumstances. Please contact the instructor if you have any concerns related to session recordings.

Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

Conduct:

Some components of this course will involve online interactions. To ensure the best experience for both you and your classmates, please honour the following rules of etiquette:

- please "arrive" to class on time
- please use your computer and/or laptop if possible (as opposed to a cell phone or tablet)
- ensure that you are in a private location to protect the confidentiality of discussions in the event that a class discussion deals with sensitive or personal material
- to minimize background noise, kindly mute your microphone for the entire class until you are invited to speak, unless directed otherwise
- [suggested for classes larger than 30 students] In order to give us optimum bandwidth and web quality, please turn off your video camera for the entire class unless you are invited to speak

- [suggested for cases where video is used] please be prepared to turn your video camera off at the instructor's request if the internet connection becomes unstable
- unless invited by your instructor, do not share your screen in the meeting

The course instructor will act as moderator for the class and will deal with any questions from participants. To participate please consider the following:

- if you wish to speak, use the "raise hand" function and wait for the instructor to acknowledge you before beginning your comment or question
- remember to unmute your microphone and turn on your video camera before speaking
- self-identify when speaking.
- remember to mute your mic and turn off your video camera after speaking (unless directed otherwise)

General considerations of "netiquette":

- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Be courteous toward the instructor, your colleagues, and authors whose work you are discussing.
- Be respectful of the diversity of viewpoints that you will encounter in the class and in your readings. The exchange of diverse ideas and opinions is part of the scholarly environment. "Flaming" is never appropriate.
- Be professional and scholarly in all online postings. Cite the ideas of others appropriately.

Note that disruptive behaviour of any type during online classes, including inappropriate use of the chat function, is unacceptable. Students found guilty of Zoom-bombing a class or of other serious online offenses may be subject to disciplinary measures under the Code of Student Conduct.

Online Proctoring Notice:

Tests and examinations in this course may be conducted using Zoom. You will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session will not be recorded.* More information about the use of Zoom for exam invigilation is available in the Online Proctoring Guidelines at the following link:

https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf.

Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements are available at the following link: https://support.zoom.us/hc/en-us.

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your instructor in advance of the test or examination.

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

Consultation:

Students are encouraged to discuss problems with their teaching assistant and/or the Instructor in tutorial sessions. Office hours will be arranged for the students to meet with the Instructor and teaching assistants. Other individual consultation can be arranged by appointment with the instructor.

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

<u>Course Breakdown:</u> (Values given in accreditation units) Engineering Science = 50%; Engineering Design = 50%