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

CEE3346b - Steel Design - Course Outline 2023/24

Introduction

This is the final lecture-based structural design course in the Civil/Structural options, and synthesizes material taken in previous structural design and analysis courses. The general objectives are for the student to become able to

- identify, formulate and solve problems involving structural steel while working individually or functioning on a team;
- recognise that the essential criteria in CSA Standard CAN/CSA-S16-19 ("Design of Steel Structures"), that address the design of steel members and structures, are simple and direct applications of the fundamentals of statics and applied mechanics;
- rapidly design steel structures, components and connections in accordance with the provisions of CSA Standard CAN/CSA-S16-19;
- improve communication skills by documenting decisions made during the design process in coherent and legible design calculations;
- appreciate professional responsibility issues in steel design and construction, and
- recognise the need for life-long learning to keep abreast of new design and construction methods, and to enhance one's abilities as a designer.

Calendar Copy:

Behaviour and Limit States Design of tension members, columns, beams, beam-columns and connections. Pdelta analysis for unbraced frames. Building systems. Current professional issues in steel construction. Health and safety issues are discussed.

Prerequisites:

CEE3340A/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.

3 tutorial hours/week

Attendance of tutorials is **mandatory**.

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

- TBA
- Students may also set up appointment for office hours with TAs

Administrative support: Ms. S. McKay, SEB3005

Textbook:

- *Handbook of Steel Construction*, 12th Edition, 2nd Printing, Canadian Institute of Steel Construction (CISC), 2023, (including CAN/CSA-S16-19 Code and Commentary). **Purchase of the Handbook is required**. Instructions for purchasing the book at a deeply discounted price are posted on the course OWL site.
- Prepared course notes, available on OWL, shall be brought to each class

Other References:

Limit States Design in Structural Steel, by Kulak and Grondin, 11th Edition, CISC, 2021. **Purchase optional**

Other excellent structural steel references are available in the Taylor Library, or online at www.cisc-icca.ca.

Units:

SI units will be used in lectures, tutorials and examinations

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

- 1. Identification and Properties of Steel and Steel Sections (Week 1) [KB4, PR1, CS1, D1, D4]:
 - a) Identify mechanical properties of steel: yield strength, toughness.
 - b) Identify Canadian and American steel grades.
 - c) Identify and determine properties of commonly-used rolled sections.
 - d) Calculate properties of built-up sections
- 2. Limit States Design Concepts (Week 2) [KB4, CS1, LL1, ITW1, D1]
- a) Classify limit states as Ultimate, Fatigue or Serviceability Limit States.
- 3. Load Paths in Structures (Weeks 2-3) [PA1, KB4, D4]
 - a) Visualize gravity load paths, and so calculate tributary areas.

b) Visualize lateral load paths, and so calculate force effects in diaphragms, bracing, and moment-resisting frames.

4. Tension Members (Week 3-4) [KB4, PR1, D1, D4, ET2]

a) Analyse tension members to determine capacity based on yield of the gross section or fracture of the net section accounting for staggered holes and shear lag.

- b) Design tension members to satisfy both Serviceability and Ultimate Limit States.
- 5. Simple Columns (Week 4-5) [KB4, PA2, PR1, D1, D4, ET2]
 - a) Determine the axial capacity of short, long, and intermediate columns using CSA S16-19.

b) Design simple columns for factored loads at Ultimate Limit States, using first principles or tables in the *CISC Handbook*.

6. Laterally Supported Beams (Weeks 5-6) [KB4, PA2, PR1, D1, D4, ET2]

a) Calculate moment-curvature relationship for W and rectangular sections.

b) Determine class of section, and equation defining flexural capacity, based on local buckling (b/t and h/w) considerations.

c) Design beams for shear forces and bending moments at Serviceability and Ultimate Limit States, using first principles or tables in CISC Handbook.

7. Laterally Unsupported Beams (Weeks 7-8) [KB4, PA2, PR1, D1, D4, ET2]

a) Calculate the elastic lateral-torsional buckling capacity of a laterally-unsupported beam subjected to uniform or non-uniform applied moments.

- b) Design laterally-unsupported beams, using tables in the CISC Handbook.
- 8. Composite Construction (Weeks 9-10) [KB4, CS1, PA2, PR1, D1, D4]
 - a) Identify effect of construction method on behaviour of composite sections.
 - b) Calculate moment resistance of composite section at Ultimate Limit State.
- 9. Stability Concepts (Week 11) [KB4, PA2, PR1, D1, D4]
 - a) Distinguish between first- and second-order analyses.
 - b) Identify effect of deformations on the behaviour of a member or a structural system.
 - c) Determine the sway amplification factor for single-storey structures using CSA S16-19.
- 10. Beam Columns (Week 12) [KB4, PA2, PR1, D1, D4, ET2]

a) Analyse cross section for combination of axial tension and bending moment.

Determine capacity for combination of axial compression and bending moment as limited by local buckling, cross-section strength, member strength based on in-plane behaviour, and member strength based on lateral-torsional buckling.

c) Calculate beam-column capacity rapidly using tables in the CISC Handbook.

- 11. Fasteners (if time permits) [KB4, PA2, PR1, D1, D4, ET2]
 - a) Identify common types of bolts, and installation methods.
 - b) Determine number and arrangement of bolts to resist shear, tension, and combined shear and

tension at Serviceability and Ultimate Limit States using CSA S16-19.

c) Rapidly design fasteners using tables in the CISC Handbook

Examinations and Quizzes:

Two one-hour quizzes will be held during tutorial hours. These quizzes are tentatively scheduled on Monday, February 12, 2024 (6:30 - 7:30 PM) and Monday, March 18, 2024 (6:30 - 7:30 PM). 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.

Both the quizzes and final examination will be open book exams.

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 at 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 material.

Evaluation

The final grade is computed as follows: Participation

Assignments	25%
Quizzes	20%
Final exam	5 <u>0%</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.

<u>English</u>

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

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

General Learning Objectives

Plagiarism Checking:

The University of Western Ontario uses software for plagiarism checking. Students are required to submit their Laboratory Reports in electronic form to Turnitin.com for plagiarism checking.

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 Western Multicultural Calendar.

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 Design = 100%