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

CEE 2220a – Introduction to Structural Engineering - Course Outline 2021

This course introduces structural analysis and design as applications of the principles of static equilibrium. The general objectives are for the student to become able to:

- identify, formulate, analyse and solve structural analysis and design problems while working individually or functioning on a team.
- conduct experiments, analyse and interpret data, synthesise results to rationally account for differences between predicted and observed structural responses, and communicate the findings effectively in concise and complete laboratory reports;
- apply knowledge of mathematics and statics to the analysis of two dimensional trusses, beams and frames;
- appreciate the importance of natural loads and evaluate structural loading from wind and snow;
- understand structural engineering drawings and create simple drawings using AutoCAD;
- proportion simple compression and tension members and design, fabricate, and test to destruction a model truss;
- improve communication skills by documenting design decisions in coherent and legible design calculations;
- develop an awareness of contemporary structures, and appreciate professional responsibility issues;
- recognize the need for life-long learning to keep abreast of new design and construction methods, enhance one’s abilities as a designer, and maintain one’s professional competence.

Calendar Copy:
A first course in Structural Theory and Design, including a consolidation of material concerning static equilibrium. Free body diagrams; behaviour, analysis and design of trusses and statically determinate steel and wooden beams; Euler buckling; force effect envelopes; snow and static wind loads.

Prequisites:  ES 1022a/b/y, AM 1413
Corequisites: CEE 2202a, AM 2270
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 are organized into weekly learning modules, including both online lectures and in-person discussion. Students should review the online lectures in the week they are posted, and be prepared to discuss and apply during the weekly lecture sessions. Review of lecture material and attendance at lecture sessions should take approximately 6 hours per week.

2 tutorial hours/week
A 2-hour tutorial session will be delivered each week. Students will be organized into teams of four at the beginning of the year. Each week, students will work on an assignment with two parts. Part A is a group assignment which will be submitted by the end of the tutorial session. Part B is an individual assignment which will be submitted at the end of the week.

Instructor:
Dr. Jon Southen, P.Eng., SEB 3116, email: jsouthen@uwo.ca.
Office Hours: by appointment.
Administrative Support: Sandra McKay, SEB 3005, smckay@uwo.ca

Textbook:
Course notes (with gaps) will be provided. These should be downloaded from the course OWL site in advance of watching/attending the lecture. The gaps will be filled in during the lectures and should be done by the student in their own set of notes while watching the lecture; this will promote active learning. Solutions to some example problems and gap-filled notes, will not be posted on the course OWL site.

Other References:
Structures or Why Things Don’t Fall Down, by J. E. Gordon, Penguin, 1979. (optional)

Laboratory:
Two laboratory sessions will be conducted during the course. These laboratories will take place in the Structures Lab (SEB 22). Student groups will conduct measurements, complete required calculations and prepare a laboratory report.

Computing:
Students are required to use personal computers running a Windows environment. Assignments may require the use of structural analysis programs West Point Bridge Designer (http://bridgecontest.usma.edu/) and Analysis (http://www.cuylaerts.net/) and the drafting package AutoCAD (http://www.autodesk.ca/en).

Units:
SI units will be used in lectures and examinations
**Specific Learning Objectives** [GA Indicator – bold denotes evaluated indicator]:

1. **Introduction: The Eye of a Structural Engineer.**
   a) Recognise potential to learn about structures by looking at them critically [KB3, PA1]
   b) Determine load paths by visual inspection of simple structures [KB3, PA1]

2. **Equilibrium.**
   a) Apply equations of equilibrium for plane and 3-dimensional structures [PA2]
   b) Idealise applied loads and restraint conditions for structural analysis [PA1]
   c) Experimentally investigate the statics and geometry of cables [I1, I3]

3. **Free Body Diagrams**
   a) Draw free body diagrams for structures, members, or parts of members [PA1, PA2]
   b) Compute external reactions or internal force effects by solving equations of equilibrium and condition, derived using free body diagram [PA2]

4. **Stability and Determinacy**
   a) Check stability and determinacy of beams, trusses and frames [PA1]
   b) Recognise that instability occurs when the structure has too few members or restraints to satisfy the equations of equilibrium [PA1]
   c) Draw the collapse mode for an unstable plane structure [PA1]
   d) Identify geometric instability due to poor arrangement of internal members or external supports [PA1]

5. **Trusses**
   a) Identify common truss configurations [KB3, PA1]
   b) Rapidly compute tension and compression forces in members using the method of joints [PA2, PA3]
   c) Rapidly compute tension and compression forces in members using the method of sections [PA2, PA3]
   d) Apply both the method of sections and the method of joints to the analysis of compound trusses [PA2, PA3]
   e) Rapidly identify zero force members in trusses [PA1]
   f) Determine deflections due to axial deformations in simple trusses [PA3]
   g) Idealise truss for analysis by computer software analysis package [PA1, PA2, ET1, ET2]
   h) Check by hand calculation results obtained from computer analysis software package [PA3, ET2]
   i) Experimentally investigate the behaviour of trusses and verify the principle of superposition [I1, I3]
   j) Design, construct, and test to failure a model truss [D1, D2, D3, D4. ITW2]

6. **Introduction to Structural Design**
   a) Identify essential design requirements at serviceability and ultimate limit states [D1]
   b) Carry out structural design as a 5-step process: (1) problem definition, (2) preliminary design of alternative solutions, (3) evaluation of alternatives, (4) final design, (5) implementation (including drawings). [D4]
   c) Classify limit states as ultimate, fatigue or serviceability limit states [D1]
7. Structural Loads
   a) Recognize the sources of loads on structures [D1]
   b) Recognize the significance of natural loads [D1]
   c) Calculate design static wind loads [D1]
   d) Calculate design snow loads [D1]

8. Structural Drawings
   a) Understand the importance of drawing as a communication tool for engineers [CS2]
   b) Recognize and interpret essential elements of a structural drawing [CS2]
   c) Use AutoCAD to create basic drawings [CS2, ET2]

9. Design of Tension Members
   a) Classify materials as brittle, ductile, stiff or flexible based on their behaviour [D1]
   b) Analyse tension members to determine capacity based on yield of the gross section or fracture of the net section, accounting for staggered holes [PA3, D4]
   c) Design tension members for factored loads at Ultimate Limit States [PA3, D4]

10. Behaviour and Design of Compression Members
    a) Determine the capacity of compression members that fail by crushing of the cross section or by Euler buckling of the member [PA3, D4]
    b) Calculate the Euler buckling load of columns with various end restraints using effective length factors [PA3, D4]

11. Beams and Frames:
    a) Draw axial force, shear force, and bending moment diagrams by any of the following methods:
       • Evaluate force effects at many locations using the method of sections
       • Derive equations for the internal force effects
       • Derive the relationships between the load, shear, and bending moment diagrams using the equations of equilibrium [PA1, PA2, PA3]
    b) Determine force effect envelopes for simple beams. [PA3]

12. Force Effect Envelopes
    a) Use superposition to create force effect envelopes representing the combined effects of dead and live loads. [PA3]

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

E=Evaluate, T=Teach, I=Introduce (Introductory Level)

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Evaluation:

The final course mark will be determined as follows:

- Assignments and Participation: 25 %
- Lab Reports: 5 %
- Truss Model Design Project: 15 %
- Quizzes: 15 %
- Final Exam: 40 %

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Total: 100%

Note: (a) **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.

(b) **Students must turn in all laboratory reports, and achieve a passing grade in the laboratory component, to pass this course.** Students who do not satisfy this requirement will be assigned 48% or the aggregate mark, whichever is less.

(c) **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.

(d) Should any of the quizzes conflict with a religious holiday that a student wishes to observe, the student must inform the instructor of the conflict no later than two weeks before the scheduled test.

(For further information on Accommodations for Religious Holidays see http://www.uwo.ca/univsec/handbook/appeals/accommodation_religious.pdf)

1. Quizzes and Examinations:

Two 50-minute quizzes will be scheduled during lecture times, tentatively on Thursday, October 14 and Thursday, November 11.

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

2. Assignments

Assignments will be given weekly during the tutorial sessions. One solution to Part A of each weekly assignment must be turned in by each group by the end of the tutorial period. Group membership will be assigned by the instructor, and may be revised during the term. All group members must sign the cover page of group submissions.

Each student must turn in one solution to Part B of each weekly assignment by 5:00 pm Friday afternoon by electronic submission to OWL. Late assignments will receive a penalty of 10%/day. Extensions are to be negotiated with the course instructor, not the teaching assistants.
In some circumstances, only a selection of questions from an assignment will be marked – the questions worth marks will not be determined or announced in advance. The intention is for students to complete the entire assignment in order to maximize learning the course material.

3. Laboratories
Laboratory reports will be prepared by teams of students assigned by the course instructor. Details regarding the laboratory report requirements will be posted to OWL.

4. Truss Design Project
In this project, teams of students will design, construct and test to failure a truss bridge structure fabricated from popsicle sticks. Students may select their own teams of 1-3 students for this project. Testing will be conducted during the week of November 29, with the final report due at the end of classes on December 8. Further details about the project will be posted to the course Owl site and discussed during a lecture.

5. 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 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](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: [Academic Accommodation for Students with Disabilities](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf).

**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:
Any remote learning sessions for this course may 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. The lecture notes and online lecture videos and tutorial sessions are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. The recording of the live/synchronous sessions of the course without the permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.

Conduct:

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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. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. 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
**Contingency:**

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining 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 at the discretion of the course instructor.

**Notice:**
Students are responsible for regularly checking their email, course website (https://owl.uwo.ca) 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.

**Course breakdown:**
Engineering Science = 50%; Engineering design = 50%.

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