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

CEE 2220a – Introduction to Structural Engineering - Course Outline 2024

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, NMM 1412A/B or the former AM 1412A/B

Corequisites: NMM 2270A/B, CEE 2202A or registration in Integrated Engineering

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 at the beginning of the year. Each week, students will work on an assignment with two parts. Part A is a team assignment which will be submitted by the end of the tutorial session. Part B is an individual assignment which will be submitted at the beginning of the following week.

2 laboratory sessions/term
Students will participate in two approximately half-hour laboratory sessions during the course. These laboratories will take place in the Structures Lab (SEB 22). Student teams will conduct measurements, complete required calculations and prepare a laboratory report. Proper PPE in the form of steel-toed boots will be required for any students interacting directly with the laboratory equipment.

Contingency plan for an in-person class pivoting to 100% online learning
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.

Instructor:

Dr. Jon Southen, P.Eng., SEB 3116, email: jsouthen@uwo.ca.
Office Hours: by appointment.

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:
Structural Analysis, A. Kassimali, CENGAGE Learning, 5th Edition, 2015. (optional)
Structures or Why Things Don't Fall Down, by J. E. Gordon, Penguin, 1979. (optional)
Mechanics of Materials (9th Edition in SI Units), R.C. Hibbeler, Pearson Prentice Hall (optional)

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). It is the student's responsibility to ensure that they have access to a computer capable of running these programs.

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**]
   i) 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]

13. Professional Engineering
    a. Recognize the professional obligations of structural engineers as prescribed by legislation. [**PR1, PR2, PR3**]
    b. Demonstrate awareness of, and application of, professional ethics and principles of equity. **[EE1, EE2, EE3, EE4]**

The instructor may expand or revise material presented in the course as appropriate.
Students should refer to the posted schedule for details about lecture and tutorial sessions.

General Learning Objectives

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

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

Accreditation Units:

Engineering Science = 50%; Engineering design = 50%.

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 %

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.

1. Quizzes and Examinations:

Two 50-minute quizzes will be scheduled during lecture times, tentatively on Tuesday, October 8 and Tuesday, November 12.

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 submitted to OWL by each team by the end of the tutorial period. Team membership will be assigned by the instructor, and may be revised during the term. All team members must sign the cover page of group submissions.

Each student must turn in one solution to Part B of each weekly assignment by 9:00 am Monday morning by electronic submission to OWL.
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 1-4 students for this project. Testing will be conducted during the tutorial session on November 27, with the final report due at the end of classes on December 6. Further details about the project will be posted to the course OWL site and discussed during a lecture.

I. Missed/Late Accommodation Policy:

1. Students missing a test/assignment/lab or examination you will report the absence by submitting an Academic Consideration Request form through STUDENT ABSENCE PORTAL.
2. Documentation must be provided as soon as possible.

II. Exam Accommodation:

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
   PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

III. Late Assignments:

1. Students must advise the course instructor if they are having difficulty completing an assignment on time (prior to the due date of the assignment).
2. Students should be prepared to submit the Academic Consideration Request Form and provide documentation if requested to do so by the course instructor (see reverse side for information on documentation).
3. If granted an extension, a revised due date should be established with the course instructor. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. This course has 17 assignments (counting parts A and B as separate assignments) with only 14/17 assignments counted towards your final grade. Academic consideration will not be granted for missed assignments. If students miss 3/17 assignments, the remaining 14 assignments will be used in the calculation of the final grade. If students miss more than 3 assignments, they will receive a grade of zero on each additional missed assignment.
5. This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. Should students submit their assessment beyond 72 hours past the deadline, a late penalty of 20% per day will be subtracted from the assessed grade. As flexible deadlines are used in this course, requests for academic consideration will not be granted. If you have a long-term academic consideration or an accommodation for disability that allows

greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.

6. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

IV. Medical Accommodation:

1. Requests for Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Requests for academic consideration must include the following components:
    a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
    b. Medical note
    c. Indication of the course(s) and assessment(s) affected by the request
    d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline. Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Engineering.

V. Religious Accommodation:

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

VI. Academic Integrity:

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit Academic Integrity Western Engineering for more information

VII. Academic Offences:

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.

Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know

Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VIII. Faculty of Engineering AI Policy:

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.
GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

IX. Use of English Policy:

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 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.

X. Accessibility:

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the Accessibility Western University for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit Academic Support & Engagement -Academic Accommodation.

XI. Inclusivity, Diversity, and Respect:

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic

status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the Office of Equity, Diversity and Inclusion.

XII. Health and Well-Being:

- Health & Wellness Services – Students - Offers appointment-based medical clinic for all registered part-time and full-time students.
- Mental Health Support - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- Crisis Support - For immediate assistant, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click here.
- Gender-Based Violence and Survivor Support - Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, here. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts:

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Civil & Environmental Engineering	SEB 3005	519-661-2139	civil@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links:

- WESTERN ACADEMIC CALENDAR
- ACADEMIC RIGHTS AND RESPONSIBILITIES