

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

CEE 2220a – Introduction to Structural Engineering - Course Outline 2017

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.

Contact Hours:

3 lecture hours/week; 2 design laboratory/tutorial hours; (recommended additional personal study - 3 hours).

Attendance at the tutorial/laboratory session is **mandatory**

<u>Prerequisites:</u>	ES 1022a/b/y, AM 1413
<u>Corequisites:</u>	CEE 2202a, AM 2270
<u>Antirequisites:</u>	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.

Instructor:

Dr. Jon Southen, P.Eng., SEB 3116, email: jsouthen@uwo.ca. *Administrative Support:* Room 3005

Textbook:

Prepared class notes should be brought to each class, and may be downloaded from the course website (<http://owl.uwo.ca>).

Other References:

Structural Analysis, A. Kassimali, CENGAGE Learning, 5th Edition, 2015. (Purchase optional)

Structures or Why Things Don't Fall Down, by J. E. Gordon, Penguin, 1979. (Purchase optional)

Mechanics of Materials (9th Edition in SI Units), R.C. Hibbeler, Pearson Prentice Hall (Purchase recommended)

Laboratory:

One session for testing model trusses designed and built by individuals or teams of two students

AND

Two laboratories assigned by the instructor with reports submitted by teams of three students.

AND

One session to work on AutoCAD drawing.

Laboratory reports will be due in Locker 53, Second Floor of the Spencer Engineering Building, at 9:30 on the Monday morning immediately following the laboratory.

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:

1. Introduction: The Eye of a Structural Engineer. At the end of this section, the student should be able to:
 - a) Recognise potential to learn about structures by looking at them critically
 - b) Determine load paths by visual inspection of simple structures

2. Equilibrium.
 - a) Apply equations of equilibrium for plane and 3-dimensional structures
 - b) Idealise applied loads and restraint conditions for structural analysis

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

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

5. Trusses
 - a) Identify common truss configurations
 - b) Rapidly compute tension and compression forces in members using the method of joints
 - c) Rapidly compute tension and compression forces in members using the method of sections
 - d) Apply both the method of sections and the method of joints to the analysis of compound trusses
 - e) Rapidly identify zero force members in trusses
 - f) Determine deflections due to axial deformations in simple trusses
 - g) Idealise truss for analysis by computer software analysis package
 - h) Check by hand calculation results obtained from computer analysis software package
 - i) Design, construct, and test to failure a model truss

6. Introduction to Structural Design
 - a) Identify essential design requirements at serviceability and ultimate limit states
 - 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).
 - c) Classify limit states as ultimate, fatigue or serviceability limit states

7. Structural Loads
 - a) Recognize the sources of loads on structures
 - b) Recognize the significance of natural loads
 - c) Calculate design static wind loads
 - d) Calculate design snow loads

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

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

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
 - b) Calculate the Euler buckling load of columns with various end restraints using effective length factors

11. Beams and Frames:
 - a) Draw axial force, shear force, and bending moment diagrams by any of the following three 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
 - b) Determine force effect envelopes for simple beams.

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

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

General Learning Objectives

E=Evaluate, T=Teach, I=Introduce (*Beginner or Intermediate or Advanced Level*)

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

Evaluation:

The final course mark will be determined as follows:

Weekly Assignments:	18 %
Lab Reports	4 %
Truss Model Design Project	8 %
Quizzes:	20 %
Final Exam:	50 %

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 tutorial periods, tentatively on October 19 and November 16. Programmable calculators are **not** permitted in the final exam and quizzes. Both quizzes and the final examination will be **CLOSED BOOK: no programmable calculators or other external sources of information, including books, notes or crib sheets, are permitted.** A list of acceptable calculators for closed book exams will be posted on the bulletin board across from the Department of Civil and Environmental Engineering Office: please be sure your calculator is on it! **Part marks may not be awarded for some of the problems on the quizzes or final exam.**

2. Weekly Assignments

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 10:30 am Monday mornings in LOCKER 53, second floor, Spencer Engineering Science. Late assignments will receive a grade of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants.

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 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.

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, 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.

Accessibility:

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

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. 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>

Sickness and Other Problems:

Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see:
http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf

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 instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate 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.

***INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS
OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED***

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic accommodation will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services office if you are in first year) that there are compelling medical or compassionate grounds that can be documented before academic accommodation will be considered. Different regulations apply to term tests, final examinations and late assignments. Read the instructions carefully. (see the [2016 Western Academic Calendar](#)).

A. GENERAL REGULATIONS & PROCEDURES

1. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
2. Bring your request for academic accommodation to the attention of the Chair of the department (or the Undergraduate Services office if you are in first year) prior to the scheduled time of the test or final examination or due date of the assignment. If you are unable to contact the relevant person, leave a message with the appropriate department (or Undergraduate Services office, if you are in first year). The addresses, telephone and fax numbers are given at the end of these instructions. Documentation must be provided as soon as possible.
3. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or exam reweighted on a retroactive basis is not permitted.

B. TERM TESTS

1. If you are unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) prior to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).
2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).

3. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair (or the Undergraduate Services Office if you are in first year) is required when rescheduling term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office **PRIOR TO THE SCHEDULED EXAMINATION TIME** to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number (please spell your full name).
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, 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 sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

***N.B.* It is the student's responsibility to check the date, time and location of the special examination.**

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.

- ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

SHORT ABSENCES

If you miss a class due to a minor illness or other problems, check your course outlines for information regarding attendance requirements and make sure you are not missing a test or assignment. Cover any readings and arrange to borrow notes from a classmate.

EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or the counsellors in the Undergraduate Services Office if you are in first year.

DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office if you are in first year). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

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

ACADEMIC CONCERNS

You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Calendar References: Check these regulations in your 2016 Western Academic Calendar available at www.westerncalendar.uwo.ca.

[Absences Due to Illness](#) - page 117

[Academic Accommodations for Students with Disabilities](#) - page 118

[Academic Accommodations for Religious Holidays](#) - page 119

[Incomplete Standing](#) - page 104

[Scheduling of Term Assignments](#) – page 97

[Scholastic Offences](#) - page 113

[Special Examinations](#) - page 132

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Drop Deadlines:

First term half course (i.e. “A” or “F”):

November 5, 2016

Full courses and full-year half courses (i.e. “E”, “Y” or no suffix):

November 30, 2016

Second term half or second term full course (i.e. “B” or “G”):

March 7, 2017

Undergraduate Services Office:	SEB 2097	telephone: (519) 661-2130	fax: (519) 661-3757
Dept. of Chemical and Biochemical Engineering:	TEB 477	telephone: (519) 661-2131	fax: (519) 661-3498
Dept. of Civil and Environmental Engineering:	SEB 3005	telephone: (519) 661-2139	fax: (519) 661-3779
Dept. of Electrical and Computer Engineering, Software Engineering Mechatronics Engineering	TEB 279	telephone: (519) 661-3758	fax: (519) 850-2436
Dept. of Mechanical and Materials Engineering:	SEB 3002	telephone: (519) 661-4122	fax: (519) 661-3020

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