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

CEE 2221 – Structural Theory and Design - Course Outline 22/23

Objectives:
This course focuses on identification, formulation, analysis and design of civil engineering structures. The general objectives are for the student to develop the ability to:

• Identify the load path and tributary loading for surface loads on statically determinate three-dimensional structures;
• Calculate the reactions and draw the internal force diagrams for statically determinate two-dimensional structures based on equilibrium;
• Calculate the deflections of statically determinate two-dimensional structures using the moment-area method and 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 between working stress and ultimate 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.

Pre-requisites: CEE 2202A/B, CEE 2220A/B, AM 2270A/B
Corequisites: None
Antirequisites: None

Note: It is the student’s responsibility to ensure that all Pre-requisite and Co-requisite 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 Anti-requisite. The students may be dropped from the course or not given credit for
the course towards their degree if they violate the Pre-requisite, Co-requisite or Anti-requisite conditions.

**Contact Hours:**
- **3 lecture hours/week:** Lectures will be delivered in-person. 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.
- **2 tutorial hours:** A 2-hour in-person tutorial session will be delivered each week. Student attendance of the tutorial is mandatory. Attendance marks will be given for each tutorial.

**Contact Information:**
Instructor: Hassan EL-Chabib, PhD, P. Eng., SEB 3029
Email: delchab2@uwo.ca
Office hour: Tuesday, 11:00 am – 12:00 pm or by appointment
Administrative Assistant: SEB 3005 or (civil@uwo.ca)

**Textbook and Notes:**
- Course notes will be regularly posted on the course website on OWL as needed. It is the student’s responsibility to regularly check the course website and print notes if required.

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

**Specific Learning Objectives:** (GA indicators – bold represents evaluated indicators):
At the completion of the course, the student should be able to:

1. **Introduction (Week 1).**
   a) Recognize basic types of structural elements, structures, loads and load paths [KB3, KB4];
   b) Distinguish working stress design and limit states design, and [KB4]
   c) Know the purposes of the Canadian national building code and various design codes [KB4].

2. **Structural Idealization and Tributary Loading (Weeks 1 – 2).**
   a) 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];
   b) Create idealized framing plans for simple structures [KB4, PA1, PA2], and
   c) Identify the load path and compute the tributary loading for vertically applied surface loads [KB4, PA1, PA2].

3. **Analysis of Beams and Plane Frames (Weeks 2-4).**
   a) Quantify 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].
4. **Introduction to Strength Design (Week 5).**
   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].

5. **Deflection Calculation (Weeks 5-8).**
   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].

6. **Influence Lines (Weeks 9-11).**
   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].

7. **Introduction to Indeterminate Structures (Week 12).**
   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].

### General Learning Objectives

<table>
<thead>
<tr>
<th>E=Evaluate</th>
<th>T=Teach</th>
<th>I=Introduce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Analysis</td>
<td>E</td>
<td>Team Work</td>
</tr>
<tr>
<td>Investigation</td>
<td>-</td>
<td>Communication</td>
</tr>
<tr>
<td>Design</td>
<td>I</td>
<td>Professionalism</td>
</tr>
<tr>
<td>Engineering Tools</td>
<td>-</td>
<td>Impact on Society</td>
</tr>
</tbody>
</table>

**Evaluation:**
The final course mark will be determined as follows:

- Quizzes (3): 30%
- Attendance/Participation: 10%
- Assignments: 20%
- Final examination: 40%

Total: 100%

**Note:** Students who have failed an Engineering course (i.e. < 50%) 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, if applicable, cannot be resubmitted for grading by the student in subsequent years.

1. **Quizzes and Examinations**
   - Three one-hour quizzes are tentatively scheduled during the tutorial or lecture period at the following dates: February 17; March 10, and April 03. Classroom for the quizzes will be announced in due course.
   - **Final Exam:** 3-hour final examination will be held during the final examination period
Quizzes and examinations will be closed book and only non programmable calculators are permitted. Students should consult the list of approved calculators posted outside the Civil and Environmental Engineering Department Office.

2. Missed Quiz or Midterm
The policy of the department of Civil and Environmental Engineering is that there will be no make-up for missed quizzes or midterms. For those that do legitimately miss a quiz or midterm and provide the required supporting documentation, the standard practice will be that the weight of the missed quiz/midterm will be reassigned to the final exam.

3. Assignments
Assignments will be given on a bi-weekly basis and each student must submit a solution of all assignments. Assignments are to be submitted prior to the due date to OWL. Late assignments will receive a mark of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants. If an assignment is missed without appropriate accommodation, students will receive a mark of ZERO. Only a selection of questions from an assignment may 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.

4. 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, 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.

5. Academic Integrity:
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

6. 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.

Accommodation and Accessibility:
- Students are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:
https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

- 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. 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 if they have any problems that could affect their performance in the course. The student should seek advice from the instructor regarding how best to deal with the problem. Failure to notify the instructor immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

- **Assessments worth less than 10% of the overall course grade:**
  For work worth less than 10% of the total course grade, academic consideration might be granted by the instructor to students with a legitimate reason. If approved, an extension will be given to submit any missing work. In such a case where documentation is required, please visit: https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

- **Assessments worth 10% or more of the overall course grade:**
  https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

**Absences from Final Examinations**
https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

**Note:** missed work can *only* be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is *not* sufficient on its own.

**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.

**Course breakdown:** Engineering Science = 50%; Engineering Design = 50%