McMaster University | Civil Engineering

# COURSE OUTLINE

## COURSE INFORMATION

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| **Course Name:** | Modern Methods of Structural Analysis | Course Code: CIVENG 4K04 |
| **Session Offered:** | Fall 2025 (Term 1) | |
| **Calendar Description:** | Stiffness method; development and applications in structural analysis. Introduction to finite element method. Influence lines, elastic stability analysis of frames with and without sway effects. Application of computer programs. | |
| **Prerequisites:** | CIVENG 3G04 | |
| **Instructor:** | Saber A. S. Fosoul, Ph.D. | alesahes@mcmaster.ca |
| **Teaching Assistants:** | Khaled Emam<br>Rishav Jaiswal | emamk@mcmaster.ca<br>jaiswr2@mcmaster.ca |
| **Lectures:** | Tuesdays, Thursdays, and Fridays | 8:30 – 9:20 |
| **Tutorials:** | Tuesdays | 16:30 – 18:20 |
| **Website:** | On the Avenue to Learn (http://avenue.mcmaster.ca). All announcements, course materials, assignment problems, solutions, etc. will be posted there. It is your responsibility to check the course website regularly. | |
| **TA Office Hours:** | Thursdays<br>This is best for specific questions related to the next assignment. Zoom link will be provided on the course website. | 10:00 – 11:00 (In-person and via Zoom) |
| **Instructor Office Hours:** | To be announced based on class schedules<br>This is best for general questions regarding the course concepts that could not be sufficiently addresses during lectures. | |
| **Accommodations:** | Please feel free to reach out to discuss your unique circumstances. We will work with each other to arrange accommodations that may be needed to help you achieve your learning goals for this course. | |

## 1. COURSE OBJECTIVES

This course emphasizes the analysis of real structural systems, a process that inherently requires simplifying the problem to a level where forces and displacements can be determined with an acceptable degree of accuracy. To achieve this, a range of structural analysis techniques will be examined.

The **first part** of the course will focus on truss analysis, covering approximate methods, energy methods (with particular emphasis on the principle of virtual work), and matrix methods (i.e., the direct stiffness method), which forms the foundation of most modern structural analysis software (e.g., SAP2000).

The **second part** of the course will extend these methods to the analysis of beams and frames. This section will also introduce the concept of influence lines as a means of identifying critical loading cases in beam structures.

In the **third part** of the course, the discussion of matrix stiffness methods will be expanded to include finite element analysis of planar area elements.

Throughout the course, attention will be given to techniques for rapidly estimating solutions to common structural analysis problems. These approximate solutions will be compared with results from more advanced computational models, both to verify the accuracy of the latter and to highlight the limitations of the simplified approaches.

## 2. COURSE SPECIFIC POLICIES

1. All lectures and tutorials are mandatory.
2. All email exchanges are to be via McMaster University email accounts. Emails from non-McMaster accounts will not receive a reply and will not be valid via Avenue.
3. Lecture notes, additional notes and assignments will be posted on Avenue. Students are expected to check and read all the materials posted on Avenue.
4. The course schedule in Section 3 is tentative. The instructor and the University reserve the right to modify elements of the course during the term. Any changes you will be announced in class and/or posted on Avenue.

**REQUIRED COURSE TEXT**

- Leet K, Uang C-M, Lanning J. 2020. Fundamentals of Structural Analysis, 6th Ed. McGraw-Hill.
- Kassimali, A. 2020. Structural Analysis, 6th Ed. Cengage Learning.

**SAP2000**

You will be asked to install the latest version of SAP2000 on your computers. For this purpose, an educational license will be provided by which you are able to analyze simple structures. Some assignments will ask you to analyze a simple structure by SAP2000 and compare your results with hand calculations. Using SAP2000 will NOT be a part of your term tests or final exam.

## 3. SCHEDULE (TENTATIVE)

| | Week | Lecture topics (subject to change without notice) | Assessment |
|---|---|---|---|
| 1. | Sep 2 | Introduction /Trusses/SAP2000 | |
| 2. | Sep 9 | Trusses: Approximate Methods | Assignment 1 |
| 3. | Sep 16 | Trusses: Method of Virtual Work | Assignment 2 |
| 4. | Sep 23 | Trusses: Direct Stiffness Method | Assignment 3 |
| 5. | Sep 30 | Trusses: Large and Complex Problems | |
| 6. | Oct 7 | Beams and Frames: Estimating by Inspection | Assignment 4 |
| | **Oct 14** | **Midterm Recess: No Lectures or Tutorial** | |
| 7. | Oct 21 | Beams and Frames: Approximate Methods | **Term Test 1 – October 21** |
| 8. | Oct 28 | Beams and Frames: Method of Virtual Work | Assignment 5 |
| 9. | Nov 4 | Beams and Frames: Influence Line | Assignment 6 |
| 10. | Nov 11 | Beams and Frames: Direct Stiffness Method | Assignment 7 |
| 11. | Nov 18 | Beams and Frames: Direct Stiffness Method | **Term Test 2 – November 18** |
| 12. | Nov 25 | Introduction to Finite Element Analysis | Assignment 8 |
| 13. | Dec 02 | Big Problems | Assignment 9 |
| Final Examination | | Scheduled during the regular University Final Examination period established by the Registrar's Office | |

| 4. ASSESSMENT OF LEARNING | WEIGHT% |
|---|---|
| Assignments | 20% |
| Term Tests | 40% |
| Final Exam | 40% |

**Lectures and Tutorials:** The classes and tutorials are the primary means for delivering the course material and for regular communication between the instructor/TAs and the class. The lectures and tutorials will be used to present theoretical background and some illustrative examples. The tutorials will also be used to demonstrate additional examples, provide assistance with problem solving, and complete a portion of the current assignment. In certain situations, the tutorial session may also be used to give a lecture and vice versa.

**Assignments:**

1. All announcements, assignment problems, solutions, etc. will be posted on Avenue to Learn (http://avenue.mcmaster.ca). It is your responsibility to check the web site regularly for new postings.
2. Assignments are to be submitted through Avenue to Learn, do not submit assignments by email. Each submission must be uploaded as a single file, and the most recent version will be considered for grading. The purpose of the assignments is to deepen your understanding of the course material. While discussing general approaches and background ideas with classmates is encouraged, it is important that you are able to solve each problem independently. All work that you submit for grading must be your own work. Assistance on working out these problems will be available during the tutorial sessions.
3. You are encouraged to discuss the feedback that you receive on any assessment with your TAs or the course instructor. If you believe that you have received an incorrect grade on any piece of assessment, you must return it to the person who marked it, together with a written explanation of why you believe the grade was incorrect, within one week of the day that the assessment was returned. This may result in the grade increasing, decreasing, or remaining the same.

Accommodations for missed academic work with a granted relief are as follows:

1. Term tests: there will be no makeup test and the missed test grade portion will be re-allocated to the final examination.
2. Assignments will be extended by the same length as the approved absence; however, late submissions without granted relief will incur a penalty of 20% per day, and assignments submitted more than five days past the deadline will not be accepted.

**FINAL EXAM**

This will be a cumulative synchronous exam, to be scheduled during the regular University Final Examination period established by the Registrar's Office.

**ACADEMIC INTEGRITY**

As an example of the Academic Integrity Policy (Section 7), most problem set questions in this course will have a single correct answer. While you are encouraged to discuss your solution technique with your classmates, copying some or all of the solution from another student is considered an example of academic dishonesty. Term tests and the final exam are expected to be completed independently; both receiving and giving information regarding these assessments before all students have completed them are considered examples of academic dishonesty.

**MSAFs**

If you do not write a term test or submit an assignment at the scheduled time and you do not file a MSAF you will receive a grade of zero on the missed work. Additional details can be found at http://mcmaster.ca/msaf/.

## 5. LEARNING OUTCOMES

**When you have successfully completed this course, you will be able to:**

- use exact and approximate hand methods to estimate the forces and displacements associated with trusses, beams, and frames [CEAB Indicators 1.3 and 1.4]
- use the method of virtual work to calculate the displacements of structures [1.4]
- create and use influence lines to identify critical loading locations in beams [1.4]
- use matrix methods (i.e. the direct stiffness method) to calculate the forces and deflections in planar trusses, beams, and frames under a variety of loading conditions, including geometric nonlinearities [1.4]
- use SAP2000 to facilitate these calculations [5.2]
- describe the fundamental assumptions of finite element analysis and identify situations that require it [1.4]

**With this knowledge base, you will be able to:**

- select a structural analysis technique, whether simple or sophisticated, that is appropriate for the complexity of the problem and the resources available [2.2, 3.2, and 5.1]
- critically examine the results of one analysis method using insights from other methods [2.3 and 3.3]
- identify the assumptions and limitations that are inherent in particular analysis methods [2.1 and 2.3]

## 6. COMMUNICATION

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their "@mcmaster.ca" alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

## 7. POLICIES

### ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/.

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

## AUTHENTICITY / PLAGIARISM DETECTION

**Some courses may** use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

## COURSES WITH AN ON-LINE ELEMENT

**Some courses may** use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

## ONLINE PROCTORING

**Some courses may** use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

## CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

## ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

## REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

The McMaster Student Absence Form is a self-reporting tool for **Undergraduate Students** to report absences that last up to 5 days and provides the ability to request accommodation for any missed academic work. Please note, this tool cannot be used during any final examination period. You may submit a maximum of 1 Academic Work Missed requests per term. It is **your** responsibility to follow up with your Instructor immediately regarding the nature of the accommodation. If you are absent more than 5 days or exceed 1 request per term you **must** visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation. This form should be filled out immediately when you are about to return to class after your absence.

## ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

## COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

## PROTECTION OF PRIVACY ACT (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades, and all other personal information at all times. For example, the submission and return of assignments and the posting of grades must be done in a manner that ensures confidentiality – see http://www.mcmaster.ca/univsec/fippa/fippa.cfm.

## ANTI-DISCRIMINATION

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer, or the Human Rights Consultant, as soon as possible.
https://www.mcmaster.ca/policy/General/HR/Discrimination_and_Harassment.pdf

## EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

| 8. MCMASTER GRADING SCALE | | |
|---|---|---|
| **Grade** | **Equivalent Grade Point** | **Equivalent Percentages** |
| A+ | 12 | 90-100 |
| A | 11 | 85-89 |
| A- | 10 | 80-84 |
| B+ | 9 | 77-79 |
| B | 8 | 73-76 |
| B- | 7 | 70-72 |
| C+ | 6 | 67-69 |
| C | 5 | 63-66 |
| C- | 4 | 60-62 |
| D+ | 3 | 57-59 |
| D | 2 | 53-56 |
| D- | 1 | 50-52 |
| F | 0 | 0-49 |