McMaster University | ENGINEERING

COURSE OUTLINE

COURSE INFORMATION

Course Name:	Structural Dynamics and Seismic Design Course Code: CIV ENG 4DD4
Session Offered:	Winter 2025
Calendar Description:	Introduction to linear elastic structural dynamics including single and multi degree-of-freedom systems. Introduction to seismic design philosophy including capacity design, ductility, and collapse mechanisms. Design, detailing, and analysis of selected lateral force resisting systems will be covered using current design codes.
Pre-Requisites:	CIVENG 3G04 and CIVENG 3J04 and credit or registration in CIVENG 4N04
Instructor:	Ramla K. Qureshi, PhD (quresr11@mcmaster.ca)
Teaching Assistants:	Mendy Laoda (laodam@mcmaster.ca) Ahmed Sherif (sheria14@mcmaster.ca)
Lectures:	Tuesday, Wednesday, and Friday 9:30AM - 10:20AM
Tutorials:	Friday 2:30PM - 4:20PM
Instructor Office Hours:	By appointment via email.
TA Office Hours:	TBD.
Course Materials:	In alignment with my commitment to Universal Design for Learning (UDL) principles, this course has been designed to offer multiple ways for you to engage with the content, ensuring that all learning needs are met. You'll have opportunities to interact directly with me and the TAs during in-person lecture and tutorials, while also having access to recorded materials that you can review at your own pace. All lecture slides, notes, and examples will be available on the course website after class to support diverse learning preferences. These resources are meant to enhance your in-class experience, not replace it. Active participation during lectures is the most effective way to understand course material. If you miss a class, connect with your classmates first, then review the online materials, and use instructor and TA office hours for additional support. I'm dedicated to creating a flexible and inclusive learning environment, so please reach out if you need any additional accommodations or support.
Website:	On Avenue to Learn (http://avenue.mcmaster.ca). Please sign up immediately because important information and course documents will be posted there. **It is your responsibility to check the course website regularly.**

1. COURSE OBJECTIVES

This course serves an introduction to the principles of structural dynamics and seismic design. Topics include, but are not limited to:

- **Principles of Structural Dynamics** (Single and Multiple Degrees of Freedom Systems)
- **Seismic Design Philosophies and Design Codes** (Load Combinations, Capacity Design, Ductility, and Strength and Drift requirements)
- **Design and Detailing of Lateral Force Resisting Systems** (Moment Resisting Frames, Braced Frames, Shear Walls, etc.)

2. COURSE SPECIFIC POLICIES

Textbooks and Resources:

Required:

1. Handbook of Steel Construction, 12th Edition. Canadian Institute of Steel Construction, Markham ON. (*Also used for CIVENG 4N04*)
2. Concrete Design Handbook, 4th Edition, 2nd Revised Printing. Cement Association of Canada, Ottawa ON. (*Also used for CIVENG 3J04*)
3. National Building Code of Canada (2020) – **Electronic Copy**: https://doi.org/10.4224/w324-hv93

(*Strongly*) Recommended:

1. Chopra, A.K. (2023). Dynamics of Structures: Theory and Applications to Earthquake Engineering, 6th edition, Pearson. ISBN-13: 9780137602605 (2023 update).
2. Filiatrault A., Tremblay R., Christopoulos C., Folz B., Pettinga D. (2013). Elements of Earthquake Engineering and Structural Dynamics, 3rd edition, Presses inter Polytechnique. ISBN-10: 2553016492, ISBN-13: 9782553016493.
3. Bruneau, Michel., Uang, Chia-Ming. (2011) Ductile Design of Steel Structures, 2nd Edition. United Kingdom: McGraw-Hill Education. ISBN: 9780071623957, 0071623957.

Software:

If time permits, I may run a tutorial session on dynamic analysis of structures using any **one** of the following software tools: SAP2000, OpenSees, or Dlubal RFEM6. More details will be discussed in class.

Course Design Project: (*Individual Work – No Teams Required*)

As a key component of this course, each student will complete a comprehensive individual design project focusing on the seismic performance of a mid-rise building in a high-seismic region. This will include up to five lateral force-resisting systems designed to adhere to Canadian standards, such as NBCC 2020, CSA S16, CSA A23.3, and CSA O86, where applicable. This project is designed to reinforce and expand your understanding of structural dynamics and seismic design principles, and to provide practical experience in applying Canadian codes and standards to real-world engineering scenarios. By completing this project, you will learn to:

- Apply the seismic design process for various structural systems,
- Evaluate and compare different seismic-resisting systems based on performance and design considerations,
- Demonstrate individual competence in seismic analysis, design, and code compliance, and
- Develop professional communication and technical writing skills through clear and concise reporting.

Course Expectations:

This course is designed to provide an engaging environment that supports all students in becoming proficient structural engineering professionals. To achieve this, we will approach the course as a real-world engineering design office, with the following expectations to ensure a productive and collaborative learning experience:

- **Be punctual.** Just as in a professional setting, arriving on time demonstrates respect for colleagues and ensures you don't miss important information. If late, minimize disruption by quietly taking the first available seat.
- **Come prepared to work.** Preparation is key in engineering practice. Review course materials beforehand and bring necessary stationary and a calculator to engage actively in each session.
- **Keep communication professional:** Communicate clearly and respectfully with peers and instructors, reflecting the professionalism expected in the field. This includes respecting diverse perspectives and approaches in discussions and project work.

- **Submit assignments on time.** Meeting deadlines is a standard expectation in professional practice, and a similar expectation is upheld in this class.
- **Submit original work.** Do not present someone else's work, ideas, or words as your own. Use of any form of GenAI, unless discussed in the classroom and assigned as part of homework, is considered plagiarism.
- **Minimize disruption.** Maintain a focused learning environment by silencing or turning off mobile phones and electronic devices during class. If you must, only use electronic devices for class purposes. If you are disrupting the class, you may be asked to leave, and a meeting with the Chair of the Department may be required. If you are affected by the behavior of other students, please inform me via email so that I can address your concerns.

Equity, Diversity, and Inclusion

You belong here, and you have a right to an environment that is free of discrimination and harassment. If you have any concerns, please do not hesitate to contact me or the Equity and Inclusion Office (https://equity.mcmaster.ca/contact-us/). If something was said in class (by anyone, including me) that made you feel uncomfortable, it is always an option to speak to me about it or to send anonymous feedback.

Extreme Circumstances and Other Modifications

In accordance with McMaster Policy, I may adjust the lecture and assessment schedule during the term. If this happens, the class will be given reasonable notice, an explanation, and an opportunity to comment, although I will not necessarily make changes in response to comments received. It is your responsibility to stay informed of changes by attending all lectures and by checking the course website regularly.

3. APPROXIMATE SCHEDULE

Week	**Lecture Topics** (subject to change without notice)	**Due Dates** (subject to change)
1. 7 Jan	Introduction to Seismicity	
2. 14 Jan	SDOF Systems	
3. 21 Jan	SDOF Systems	Assignment 1
4. 28 Jan	MDOF Systems	Assignment 2
5. 4 Feb	Linear Seismic Analysis	Assignment 3
6. 11 Feb	Ductility, Inelastic behavior, and Capacity Design	**Midterm Exam (14 Feb during tutorial)**
18 Feb	**No Classes or Tutorials**	
7. 25 Feb	Code procedures	Project Report 1
8. 4 Mar	Seismic Design: Steel MRF	
9. 11 Mar	Seismic Design: Steel Braced Frames	Project Report 2
10. 18 Mar	Seismic Design: Reinforced concrete moment frames	
11. 25 Mar	Seismic Design: Reinforced concrete shear walls	Project Report 3
12. 1 Apr	Seismic Design: CLT Shear walls	
13. 8 Apr	Course Review	Project Report 4
FINAL EXAM	N/A.	

4. ASSESSMENT OF LEARNING	WEIGHT
Midterm Exam **(during Tutorial Time)**	30%
Assignments	30%
Project Reports	40%

Notes:

1. **Submission:** All assignments will be submitted in the designated dropboxes on the course website.

2. **Late Submissions:** If an assignment will be accepted after the regular deadline, the deadline for late submissions will be listed on the assignment. A deduction of 20% will apply (e.g., a student who scores 80% on the assignment will receive 60% if it is submitted late).

3. **Discussions of Feedback:** You are encouraged to discuss the feedback that you receive on any assignment or exam 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.

4. **MSAFs:** In accordance with university policy, the McMaster Student Absence Form (MSAF) may be used to request relief for missed work, and must be followed promptly by an email from the student. For assignments, the accommodation for a Type A MSAF (Self-Report) will be to waive the late penalty for the submission. **As per McMaster Policy, you cannot request a Type A MSAF (self-report) for this midterm** (weighted over 25%). If the Midterm is missed due to illness, accommodation may be requested from the Associate Dean's office. If such a request is approved, the weight of the missed Midterm will be evenly distributed to the remaining Assessments of Learning (Section 4), i.e., to the Assignments/Report.

   Accommodations for all other situations will be determined on a case-by-case basis. When accommodations are made, they will be confirmed by email from the course instructor; any grades that are missing on the course website will be counted as zero when calculating your final grade unless you have received email confirmation otherwise.

5. LEARNING OUTCOMES

Upon completion of this course, students will be able to:

1. Develop a foundational understanding of linear elastic structural dynamics, including the behavior and analysis of single and multi-degree-of-freedom systems under dynamic loading.
2. Apply concepts of structural dynamics to assess the response of structures to earthquake-induced forces and ground motion.
3. Understand the principles of seismic design, including capacity design, ductility, and mechanisms of collapse prevention, to ensure safety and performance during earthquakes.
4. Use current design codes to design and detail structural systems such as shear walls, moment-resisting frames, and braced frames for seismic resistance.

If you achieve these objectives, you will be able to contribute meaningfully to the work that structural engineers do, whether in a design office or in academia.

Graduate Attributes and CEAB Indicators

Through this course, students will develop in the following graduate attributes and indicators:

1. A knowledge base for engineering (Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.)
   - *1.3 Competence in Engineering Fundamentals*
   - *1.4 Competence in Specialized Engineering knowledge*

2. Problem analysis (An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.)
   2.1 Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.
   2.2 Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions.
3. Investigation (An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.)
   3.1 Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies.
   3.2 Synthesizes the results of an investigation to reach valid conclusions.
4. Design (An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.)
   4.1 Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions.
   4.2 Explores a breadth of potential solutions, considering their benefits and trade-offs as they relate to the project requirements.
   4.3 Develops models/prototypes; tests, evaluates, and iterates as appropriate.
   4.4 Justifies and reflects on design decisions, giving consideration to limitations, assumptions, constraints and other relevant factors.
5. Use of Engineering Tools (An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.)
   5.2 Successfully uses engineering tools.
7. Communication Skills (An ability to communicate complex engineering concepts within the profession and with society at large. Such abilities include reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.)
   7.2 Composes an effective written document for the intended audience.
8. Professionalism (An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.)
   8.2 Integrates appropriate standards, codes, legal and regulatory factors into decision making.
12. Life-Long Learning (An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.)
   12.1 Critically assesses one's own educational needs and opportunities for growth.

6. LABORATORY SAFETY

The Faculty of Engineering is committed to McMaster University's Workplace and Environmental Health and Safety Policy which states: "Students are required by University policy to comply with all University health, safety and environmental programs and policies". It is your responsibility to understand McMaster University's Risk Management system, which is supported by a collection of Risk Management Manuals (RMMs) that contain programs and policies in support of the Risk Management System. The RMMs are available from https://hr.mcmaster.ca/employees/health_safety_well-being/our-safety/risk-management-manuals-rmms/.

It is also your responsibility to follow any specific Standard Operating Procedures (SOPs) provided for specific experiments (see course lab manuals) and the laboratory equipment https://www.eng.mcmaster.ca/sites/default/files/civil_lab_health_and_safety_manual.pdf

Additionally, McMaster University's workplace health and safety guidance related to COVID-19 must always be followed (available from https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/).

The safety requirements for the ADL are listed below. Students not abiding by these safety requirements will be given one warning. Second offences will result in the student being asked to vacate the laboratory and receiving a grade of zero for that particular lab.

- Green Patch safety boots, hard hats, and safety glasses must be worn at all times. Note that students supply their own safety boots. Hard hats and safety-glasses are available in the lab. Prescription eye-glasses are only considered as safety glasses if they have side shields.
- Maintain a safe distance from the universal tester while the sample is being loaded.
- No one will create a situation that could compromise or jeopardize the safety of themselves or anyone else in the lab. Obey all instructions given to you by the Teaching Assistant and/or lab technical staff.
- No running is allowed.

7. COMMUNICATIONS

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.

8. 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.

9. 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