McMaster University | Civil Engineering

2025-26 COURSE OUTLINE

COURSE INFORMATION

Course Name: Pavement Materials and Design

Course Code: CIVENG 4G04/6G04

Session Offered: Fall

Calendar Description: 2025

Instructor(s): Hao Yang Phone: 905-523-9140 X 24930

Email: haoyang@mcmaster.ca

Office Hours/Contact: Thursday, 10 – 11 am, JHE 229

Class Schedule Day(s): 62

Time:

Lecture: Monday, Wednesday, 11:30 am – 12:20 pm, Friday 1:30 – 2:20 pm

Lab: L01 – Monday, 2:30 – 5:20 am, JHE 114

L02 – Monday, 8:30 – 11:20 am, JHE 114

Tutorial: T01 – Thursday, 2:30 – 4:20 pm, PGCLL M12

Location: ABB 136, MS Teams Code: **4buxtcu**

1. COURSE OBJECTIVES

Pavements consist of all structural elements or layers of roads above the subgrade. Functions of the pavement are: to reduce and distribute the traffic loading so that no pavement layers fail or have excess deformation; and to provide a safe, smooth and comfortable ride (serviceability) without undue delays and excessive wear and tear.

The design of pavement structures requires a good understanding of the properties of materials that the engineer must work with along with an appreciation for pavement-subgrade interaction. The first part of the course deals with materials, in particular the properties of soils, including both the subgrade and the unbound granular layers acting as structural components of pavements. The aggregates used to make asphalt concrete or Portland cement concrete must meet certain requirements to ensure that the pavements can perform their intended function over their design life. Discussion on hot-mix asphalt focuses on the Superpave technology.
The second part of the course addresses advanced analysis/design of both flexible and rigid pavement structures, including the Mechanistic-Empirical method that allows the determination of stresses and strains in the various layers of the pavement structure and subgrade by considering climate and environmental impacts. Case studies will be provided to demonstrate how both theory and different approaches are incorporated into the design and construction of both flexible and rigid pavements.

The final part of the course concerns itself with life cycle cost analysis, pavement management, an introduction to pavement sustainability, airport pavements and the impact of climate change of highway pavements.

2. COURSE SPECIFIC POLICIES

1. Class Meeting: The format of this class will be in-person. The lecture will be used to present theoretical/design background and some illustrative examples. Please note that there is not any required textbook. The course notes will contain all the necessary information. All lectures and other course materials will be uploaded to A2L. In case of the absence of the instructor (due to conferences), the lectures will be offered online through MS Teams at the scheduled times.
2. Tutorial Session: The session is provided each week to demonstrate additional examples, provide assistance with problem-solving, and for special presentations.
3. Lab Sessions: All lab sessions will be in-person. Pre-recorded videos will be assigned before the lab sessions for the class to understand the procedure of lab experiments. The students are required to watch the videos, to complete the lab with team members under scheduled time, and prepare the lab reports.
4. Attendance/Participation: **Attendance for lectures is required**. Please join the lectures at the scheduled time and attend the full class period. The students are required to review the lectures to complete the course assignments and exams. The students are also required to complete the in-class quizzes.
5. Grade Disputes: All grades are considered final and unamendable on the date in which the final grades are posted. A student can file an appeal within 10 working days of this date if the instructor has failed to implement a previously announced grade policy, awarded a grade in what has been determined to be an arbitrary or capricious manner, or violated the University's rule or policy. The student should first meet with the instructor to resolve the issue prior to beginning the appeal process.
6. Avenue to Learn: All course materials will be uploaded to Avenue for the students to review. Please check the announcement on Avenue for all course updates.

Suggested textbooks:

1. Mallick, R.B. and El-Korchi, T. (2018). Pavement Engineering: Principles and Practice (3rd edition), CRC Press, Taylor and Francis.
2. Christopher, B. R., Schwartz, C. and Boudreau, R. (2006). Geotechnical Aspects of Pavements, FHWA Report NHI-05-037. Available online at http://www.fhwa.dot.gov/engineering/geotech/pubs/05037/05037.pdf
3. AASHTO (2008). Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, Interim Edition. E-book available at McMaster Library

Additional references for your personal library of pavement engineering:

4. Huang, Yang H. (2010). Pavement Analysis and Design. Prentice-Hall. 5. Asphalt Pavement Alliance (2002). Perpetual Pavements: A Synthesis. Asphalt Pavement Alliance, 5100 Forbes Boulevard, Lanham, MD.
6. Asphalt Institute (2003). Superpave, Performance Graded Asphalt Binder Specification and Testing, SP-1, Asphalt Institute, Lexington, KY.
7. Asphalt Institute (2003). Superpave, Superpave Mix Design, SP-2, Asphalt Institute, Lexington, KY.
8. Asphalt Institute (1999). Asphalt overlays for highway and street rehabilitation, MS-17, Asphalt Institute, Lexington, KY.
9. Asphalt Institute. HMA Construction, Manual Series No. 22 (MS-22). Asphalt Institute, Lexington, KY.
10. Miller J. S. and Bellinger, W. Y. (2003). Distress Identification Manual for the LTPP (Fourth Revised Edition), FHWA-RD-03-031.

11. AASHTO (1988). AASHTO Guide for Design of Pavement Structures (4th Edition). Ebook available at McMaster Library
12. MTO (2012). Ontario's Default Parameters for AASHTOWare Pavement ME Design Interim Report.
13. Transportation Association of Canada (2013). Pavement Asset Design and Management Guide. Available at TAC online book store http://www.overklick.com/TAC/defaultTAC.aspx. (Student price $199)

3. SCHEDULE

WEEK 1 (Sep 2-5)	Pavement overview	
WEEK 2 (Sep 8-12)	Soil properties	Homework #0
WEEK 3 (Sep 15-19)	Highway base/subbase/subgrade	Homework #1
WEEK 4 (Sep 22-26)	Soil improvement and stabilization	
WEEK 5 (Sep 29 – Oct 3)	Surface drainage design	Homework #2
WEEK 6 (Oct 3 – 10)	Asphalt technology	
Oct 13-17 Midterm Recess, No Class		
WEEK 7 (Oct 20-24)	Traffic loading and volume	
WEEK 8 (Oct 27 – 31)	Pavement mechanics – flexible pavement	**Midterm**
WEEK 9 (Nov 3-7)	Pavement mechanics – rigid pavement	Homework # 3
WEEK 10 (Nov 10 - 14)	Flexible pavement design	
WEEK 11 (Nov 17-21)	Flexible pavement design	Homework #4
WEEK 12 (Nov 24-28)	Rigid pavement design	
WEEK 13 (Dec 1-4)	Final Review	
FINAL EXAMINATION	Scheduled during the regular University Final Examination period established by the Registrar's Office	

4. ASSESSMENT OF LEARNING	WEIGHT %
Assignments	15%
Midterm Exam	25%
In-Class Quiz	10%
Lab Practices	15%
Final Exam	35%

5. LEARNING OUTCOMES

Ability to understand and characterize the properties of various pavement construction materials and how to select materials to meet requirements.

• CEAB attribute 1.4 "Competence in specialized engineering knowledge "
. Ability to properly deal with uncertainties in material properties, traffic information, various assumptions in analysis and designs. • CEAB attribute 2.1 "Ability to identify reasonable assumptions (including identification of uncertainties and imprecise information) that could or should be made before a solution path is proposed "
Ability to use advanced tools for pavement structural analysis (using KenPave and PerRoad) • CEAB attribute 5.2 "The ability to use of modern/state of the art tools "
Ability to learn the current development and engineering practice in pavement engineering using provided additional reference materials • CEAB attribute 12.2 "Is aware of the wide range of engineering societies, literature, conferences, and other information sources "

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 JHE 114 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.

• Glasses or safety glasses/goggles must be worn in the lab at all times.
• Contact lenses are not to be worn in the lab.
• No short (i.e., above the knee) pants or skirts are permitted in the lab – lab coats must be worn over top of your clothing in these instances.
• Closed-toe shoes must be worn at all times.
• No loose clothing is allowed.
• Long hair must be tied back.
• Disposable latex or nitrile gloves must be worn when working with hazardous chemicals.
• Heat resistant gloves must be worn when removing hot items from the drying oven (as indicated by the laboratory instructor).
• Dust masks must be worn (as indicated by the laboratory instructor).
• Hearing protection must be worn (as indicated by the laboratory instructor).

• 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

• Ear plugs for resilient modulus test – Supplied
• Heat resistant gloves must be worn when removing hot items from the drying oven (as indicated by the laboratory instructor) – Supplied

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