

# Mechanical Engineering

## MECHENG 722

### Circular fuels: Power-to-X and X-to-Power

#### *Fall 2025*

#### Instructor Information

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Keena Trowell  
Email: [trowellk@mcmaster.ca](mailto:trowellk@mcmaster.ca)  
**Office Hours:** by appointment

#### Class Times

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**Meetings:** 1 time per week, (location and time TBD)

#### Class Format

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**Course Dates:** 02/09/2025 - 04/12/2025

**Units:** 3.00

**Course Delivery Mode:** In Person

**Course Description:** The study of energy storage in chemical form with an emphasis on energy conversion non-hydrocarbon energy carriers. Topics include metal fuels, hydrogen production, ammonia, liquid organic hydrogen carriers, water oxidation, and combustion.

#### Important Links

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- [Mosaic](#)
- [Avenue to Learn](#)
- [Student Accessibility Services - Accommodations](#)
- [McMaster University Library](#)
- [eReserves](#)

#### Course Learning Outcomes

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1. Describe energy storage concepts such as energy density, specific energy, cycle efficiency, *etc.* and perform calculations
2. Explain the basic chemistry of low-carbon energy carriers
3. Explain how energy carriers store and release energy
4. Identify and discuss inherent trade-offs of different circular fuels and technologies
5. Conduct a survey of relevant literature and identify gaps in current understanding

#### Required Materials and Texts

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**Textbook Listing:** <https://textbooks.mcmaster.ca>

No required textbook

## Course Topics<sup>§</sup>

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- What is a fuel? Power-to-X, cycle efficiency
- The basics of energy storage and conversion
- Theory of Ragone plots; Energy and power density
- Introduction to metal fuels
- Combustion
- Water
- Metal-water reactions
- Low-temperature metal-water reactions (activated)
- High-temperature metal water reactions (supercritical)
- Hydrogen production (electrolysis)
- Ammonia
- LOHCs

<sup>§</sup> Topics will be covered through a combination of student delivered lectures, seminars, and professor delivered lectures

## Course Evaluation

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### **Critical journal paper review – 10%:**

Lead a discussion on a journal paper of your choice

### **Lecture – 30%:**

Deliver a 1.5-hour lecture on a topic of your choosing as it relates to the course content

### **Research Paper – 60%**

Write a journal-style review paper on a topic of your choosing related to the course content. The final paper is due on the last day of the semester. The due dates of earlier deliverables will be communicated at the beginning of the term.

- Literature review – 15%
- Research proposal – 10%
- Detailed outline – 5%
- Final submission – 30%

## Late or Missed Assignments

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Assignments that are missed without prior approval and/or valid reason shall receive a mark of zero. Assignments missed (with approval) may be accepted late or have their weight redistributed to other deliverables at the instructor's discretion.

Assignments are due at 11:59PM on the due date. Late assignments will be penalized at a rate of 20% per day:

The best possible grade is reduced by 20% for each day after the deadline.

Time since deadline	Best possible grade
1 minute to 24 hours (1 day)	80%
24–48hrs (2 days)	60%
48–72 (3 days)	40%
72–96 (4 days)	20%

## Grading Scale

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The McMaster 12 Point 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

## APPROVED ADVISORY STATEMENTS

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### 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](https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/), located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

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

**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. Avenue to Learn, 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](http://www.mcmaster.ca/academicintegrity).

### **Courses with an On-line Element**

**Some courses may** use on-line elements (e.g. e-mail, Avenue to Learn, 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](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

## **Academic Advising**

For any academic inquiries please reach out to the Office of the Associate Dean (Academic) in Engineering located in JHE-Hatch 301.

Details on academic supports and contact information are available from:

<https://www.eng.mcmaster.ca/programs/academic-advising>

## **Requests for Relief for Missed Academic Term Work**

In the event of an absence for medical or other reasons, students should review and follow the [Policy on Requests for Relief for Missed Academic Term Work](#).

## **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.

### **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, Avenue to Learn and/or McMaster email.