CHEM ENG 4A03/6A03 – ENERGY SYSTEMS

COURSE OUTLINE 2025

COURSE DETAILS

Instructor: Dr. Giancarlo Dalle Ave
dalleagf@mcmaster.ca

Teaching Assistants:

Lectures:

Tutorials:

Office Hours:

Prerequisites: Enrollment in final year engineering program

McMaster University

DESCRIPTION

Energy systems consist of everything related to the entire energy supply chain, including extraction of raw materials, conversion of raw materials into energy products, the distribution of these products through various forms of infrastructure, and the final use of energy. In this course, we will learn about the entire energy supply chain, how to design these supply chains, and how to evaluate the sustainability of our designs.

LEARNING OUTCOMES

The purpose of the course is to provide students with a background in energy systems engineering. This course provides overviews of the largest and most important components oof major energy systems from both an isolated and systems-level perspective. Energy systems are naturally interdisciplinary. This course will mainly focus on the chemical and electrical engineering aspects of energy systems. Students who complete this course should be able to:

- Understand the importance of energy systems in our society and the need for sustainable energy
- Design energy systems for various applications, from scales ranging from building-level to national-level
- Demonstrate relevant knowledge of energy system components including resource production, energy conversion, energy transportation, and energy storage
- Construct cradle-to-product supply chains of major energy products
- Calculate mass and energy flows across a supply chain
- Assess the quality of energy systems using a variety of metrics including life cycle analyses

COURSE STRUCTURE

COURSE CALENDAR

The course is broken down into four major units:

Unit 1: Intro to energy and energy systems

Unit 2: Power generation

Unit 3: Life cycle analysis

Unit 4: Power systems and microgrids

Unit 5: Energy resources and liquid fuel production

COURSE BOOKS

There is no official textbook for this course, reading materials will be provided as necessary.

LECTURES

Lectures will be delivered live. Lectures will be recorded and posted as soon as possible after the lecture (unless something goes wrong with the recording which has happended multiple times before). Course lectures will be uploaded to the course YouTube playlist as soon as possible after the class.

Tutorials will be live and **attendance will be marked**.

IF THE INSTRUCTOR CANNOT ATTEND

If the instructor cannot attend a lecture for some reason, the class will be cancelled or a guest lecturer will cover the class or a recorded lecture will be posted to the course youtube page. An announcement will be made ahead of any absence.

COURSE INFORMATION

TERM PROJECT

The project will be related to designing, sizing, and evaluating the design of a power system for a new, rapdily growing community in Canada. This is known as a *capacity expansion problem*.

Term projects will be completed in groups of four or five for ChE 4A03. Students enrolled in ChE 6A03 must complete the project in pairs. The project will be comprehensive and include everything learned in the course. You will complete the project in stages over the course of the term by meeting the required project milestones (which will be graded mainly for feedback purposes).

You will be permitted to choose your own groups. Group selection will occur via Avenue. If you are not part of a group, I will assign you to a group. I may have to assign you to a group that has already been formed. I have executive power to reassign and reform any group as I please, but I will only do this if the system is abused or if extreme circumstances warrant. I highly recommend you chose groups from within your tutorials so you can meet together during tutorial times. Group selection will happen on Avenue. I also reserve the right to modify any groups as needed.

The term projects will be partially delivered in the form of a final presentation with supporting materials such as simulation code, spreadsheets, calculations, and written deliverables. Points will be awarded for both technical accuracy as well as quality of the communication. Project milestones will be required to be completed throughout the term. The purpose of the milestones will be to give you feedback on the project progress so that you have time to course correct going forward.

TERM PROJECT GRADING

Milestones Portion 15%

Three milestone deliverables, worth 5% of the project each (1% overall grade). Think of these as homework. A rough deescription and approximate proposed due dates for the project deliverables are:

- Milestone 1: Energy demand projections – Due Sept 30th
- Milestone 2: Power plant design and demand satisfaction – Due Nov 11th
- Milestone 3: Power system design + life cycle assessment – Due Nov 25th

Final Presentation 85%

The final project deliverable is a presentation consisting of key recommendations, a summary of design and evaluation decisions and evidence to support said decision. More information and rubrics will be provided in the project descriptions. Final project presentations will occur the final week of classes (week of Dec 1st).

PRESENTATIONS

Two presentations will be given throughout the course on advanced/future topics. Students will research a particular topic in the area and present to their peers in tutorial. The general topics for the presentations are:

- Advanced power generation technology
- Energy storage

The presentations will be completed in groups of three or four for ChE 4A03 and in-pairs for ChE 6A03. and will be delivered during the tutorials. Students can define their project groups with members from their tutorial. Each group from each tutorial will select a presentation topic from a list or a similar topic subject to approval from the instructor. More information and rubrics will be provided on Avenue.

MIDTERMS

The course will have a single written midterm. The exact date is TBD but will most likely occur during the week of Nov 3rd.

TUTORIALS

Tutorials will be used to teach supplementary material for the class including use of software. Topics taught in class will be expanded upon with practical examples. Many of the tutorials will lay the groundwork for what needs to be completed for the course project.

Tutorials are mandatory. Each tutorial is worth 1% of your final grade as an attendance mark. There are 11 tutorials total. This means that you can skip one tutorial without penalty. If you complete all 11 tutorials, you get to keep the bonus mark.

IMPORTANT LINKS

Please find below a list of important links for the class. They'll be mentioned throughout the term but a comprehensive list follows:

APPROXIMATE COURSE CALENDAR

Week	Date	Unit	Lecture	Tutorial	Assigned	Due
1	05/09/2025	1	Course Outline + Intro		Project Group Formation	
1		1	Energy Systems and Policy			
2	12/09/2025	1	Units and conversion		Milestone 1	Project Group Formation
2		1	Electricity Supply and Demand	Demand forecasting		
3	19/09/2025	2	Coal power			
3		2	Natural Gas + combined heat and power	Baseload + peaking 1		
4	26/09/2025	2	CCS		Presentation 1	
4		2	Advanced generation technology	Baseload + peaking 2		
5	03/10/2025	2	Nuclear + hydro electric		Milestone 2	Milestone 1
5		2	Wind	Peaking power + storage		
6	10/10/2025	2	Solar	Presentation 1 - Alternative power generation	Presentation 2	Presentation 1
6		2	Challenges with renewables + energy storage			
7	24/10/2025	3	LCI + LCA	Sizing renewables + storage		
7		3	LCI + LCA			
8	31/10/2025	4	Intro to power systems		Milestone 3 + final deliverable	Milestone 2
8		4	Overview power system stability	LCA 1		
9	07/11/2025	4	Electricity markets	Presentation 2 - energy storage		Presentation 2
9		4	Demand side management			
10	14/11/2025	4	Intro - microgrids and community energy			
10		4	Intro - microgrids and community energy	LCA 2		
11	21/11/2025	5	Petroleum	Picking energy storage location		
11		5	Natural Gas			
12	28/11/2025	5	Mining	Forecasting renewable supply	Milestone 3	
12		5	Bio energy			
13	No lecture					Final project
13				Project presentations		

GRADING BREAKDOWN

	Weight	Comment	Approximate Due Dates
Tutorials	10% (10 x 1%)	10 tutorials (completion marks) Note there are 11 tutorials scheduled meaning you can skip one and still get full marks or attend all and get a bonus mark	Weekly
Presentations	20% (2 x 10%)	Two presentations each worth 10% of the final grade. The presentation topics are: • Advanced power generation technologies • Energy storage technologies	1: Week of Oct 10th 2: Week of Nov 7th
Midterm	15%	2 hour written midterm	Week of Nov 4th
Project	30%	Includes graded milestone deliverables throughout the term. More details on later pages.	Milestone 1: Oct 3rd Milestone 2: Oct 31st Milestone 3 Nov 24th Final presentation: Week of Dec 1st
Final Exam	25%	2.5 hour written exam	TBD – scheduled by registrar

Note: The schedule, release dates, and due dates presented in these calendars are approximate only, please pay attention to avenue announcement and communications in-class for up-to-date information

COURSE POLICIES

DEADLINES/DUE DATES

I understand that this is only one of many courses that you're taking. Deadlines outlined in this document are not set in stone. If I assign a deadline that is unrealistic based on your other classes let me know as soon as possible and I will do my best to move it (I can't guarantee that it will be possible). The more notice you give me, the more likely I am to be able to more a due date. Handing in something late and saying that you were "too busy" or contacting me a few hours before a deadline are never valid excuses and will not result in deadlines being moved. You should be organized enough to effectively manage your own time and raise the flag well in advance when something is not feasible.

GRADING POLICIES

Valid MSAF forms for the written midterm and tutorials will result in the weight of the assessment being reassigned to the final exam. **Group presentations cannot be MSAFed.**

Midterm and final exams will be open book, open note, and open device. All devices (incuding but not limited to phones, watches, laptops, tablets) must be in airplane mode. If you're found to have a device not in airplane mode, you will automatically be given a zero on the exam and academic dishonesty procedures may be triggered. Any calculator may be used during the exams.

If technical difficulties prevent digital submissions to Avenue to Learn, email it to a TA/the instructor instead before the submission deadline.

CURVING POLICY

Only final grades will be curved based on the instructor's discretion. The curve will never lower your grade, it can only improve your grade or leave it unchanged.

ACADEMIC DISHONESTY

All marked exams are to be done individually, with no collaboration with anyone.

Tutorials will not be marked other than for completion they are for you to better your understanding, if you prefer to do it in groups, feel free to do so.

Ethical use of Large Language Models is encouraged. LLMs should be used responsibly/ethically and you should cite conversations with models that are pertinent to the work you are handing in. The Student's Guide to Writing with ChatGPT has some good suggestions for ethical use of AI (and also some BS ones in my opinion).

Plagiarism, improper collaboration, copying unauthorized tests or aids, and other academic dishonesty will not be tolerated. Your first offence will be reported to the Office of Academic Integrity.

The default penalty for academic dishonesty is a zero on the entire exam / quiz / project, even if the dishonesty occurred on just one portion or question of that exam / quiz / project. However, if Academic Integrity chooses to hold a hearing, they determine the penalty which replaces the default penalty.

Note: 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. 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.

It is your responsibility to understand academic dishonesty. See the Academic Integrity Policy at http://mcmaster.ca/academicintegrity

---

OTHER/MISC.

THE P.R.O.C.E.S.S.

The department of Chemical Engineering has a storied history of education. In addition to teaching and learning, the department is proud of our graduates not only for their academic success, but their more intrinsic traits that make them respected members of the engineering community. Recently, several high-ranking graduates from the McMaster Chemical Engineering Program employed in various industries (oil/gas, financials, etc.) were interviewed to ask what traits they look for when hiring for engineering positions. Using this information, the department would like to present to you the PROCESS: a code of conduct that we hope will guide our students throughout this program and their careers to come.

- **P**rofessionalism
- **R**esponsibility
- **O**wnership
- **C**uriosity
- **E**mpathy
- **S**elflessness
- **S**ervice

It is up to YOU to interpret these traits and apply them to your time at McMaster and your career as you see fit. These traits will not be assessed for grades but will be strongly encouraged throughout your time at McMaster. We hope that you identify with these character traits and what they mean to you, and that you trust the process.

INCLUSIVE ENVIRONMENT

Everyone in our teaching team considers the classroom to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and non-visible differences. All members of the class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class. We will gladly honour your request to address you by an alternate name or gender pronoun. Please advise us of this preference early in the semester.

COPYRIGHT AND RECORDINGS

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.

ACADEMIC ACCOMMODATIONS FOR RELIGIOUS, INDIGENOUS, OR SPIRITUAL OBSERVANCES

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.