

**MECH ENG 4Y03**  
**Internal Combustion Engines**  
Undergraduate Studies  
Fall 2023/24  
Course Outline

**CALENDAR/COURSE DESCRIPTION**

This course focuses on internal combustion engines (ICE), including operations, thermodynamics, combustion, and characteristics of gasoline and diesel engines, as well as hybrid powertrains.

**PRE-REQUISITES AND ANTI-REQUISITES**

Prerequisite(s): Registration in the final level of a Mechanical Engineering program  
Antirequisite(s):

**INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION**

**Dr. Fengjun Yan**  
Office: ITB161  
[yanfeng@mcmaster.ca](mailto:yanfeng@mcmaster.ca)  
ext. 21525

**Office Hours:**  
Thursday – 10:30am to 11:20am

**TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION**

**Francesca Madan**  
[madanf@mcmaster.ca](mailto:madanf@mcmaster.ca)

**Hosna Geraei**  
[geraeih@mcmaster.ca](mailto:geraeih@mcmaster.ca)

For any issues related to assignments, please contact **Francesca Madan**,  
For any issues related to Midterm Exam, please contact **Hosna Geraei**,  
For any other issues, please contact **either of them or Dr. Yan**.

**COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION**

<http://avenue.mcmaster.ca/>

**COURSE INTENDED LEARNING OUTCOMES**

By the end of this course, students should be able to:

1. Demonstrate understanding of basic concepts of internal combustion engines.
2. Demonstrate understanding of advantage and disadvantage of different type of engines.
3. Calculate the relevant operating parameters of a Diesel engine based on the given information.
4. Calculate the parameter and maximal brake power of spark ignition engines based on given information.
5. Understand the energy distributions and energy loss of internal combustion engines.
6. Demonstrate understanding that the exhaust gas composition calculation of an internal combustion engine.
7. Demonstrate understanding of the HEV configurations, components distributions, and energy flow in different operating conditions.

**MATERIALS AND FEES**

**Required Texts:**

N/A

**Recommended Additional Texts:**

N/A

**Calculator:**

Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

**Other Materials:**

<b>COURSE SCHEDULE</b>
------------------------

Lecture: Monday & Thursday (9:30am-10:20am); Tuesday (10:30am-11:20am) in JHE 326H

Office hour: Thursday (10:30pm-11:20am) in ITB 161

Mid-Term 1 (in class): 10:30am-11:20am October 03, 2023 JHE 326H (Tentative)

Mid-Term 2 (in class): 10:30am-11:20am October 31, 2023 JHE 326H (Tentative)

Week	Lecture	Topic	In lecture note
1	1	Introduction	
	2	Engine Operating Parameters (1)	Lecture note 1
	3	Engine Operating Parameters (2)	Lecture note 1
2	4	Engine Operating Characteristics	Lecture note 1
	5	Engine Cycle Analysis (1)	Lecture note 2
	6	Engine Cycle Analysis (2)	Lecture note 2
3	7	Engine Cycle Analysis (3)	Lecture note 2
	8	Gas and fuel Properties	Lecture note 3
	9	Intake and Exhaust Processes	Lecture note 3
4	10	Mixture in SI Engines	Lecture note 4
	11	SI Engine Combustion (1)	Lecture note 4
	12	SI Engine Combustion (2)	Lecture note 4
5	13	Knock and Fuel Requirement	Lecture note 4
	14	Diesel Engine Characteristics	Lecture note 5
	15	Diesel Engine Injection, Ignition, and Combustion	Lecture note 5
6	16	Emissions in SI Engines (1)	Lecture note 6
	17	Emissions in SI Engines (1)	Lecture note 6
	18	Emissions in SI Engines (1)	Lecture note 6
7	19	Emissions in Diesel Engine (1)	Lecture note 6
	20	Emissions in Diesel Engine (2)	Lecture note 6
	21	Diesel Engine Emission Control (1)	Lecture note 6
8	22	Diesel Engine Emission Control (2)	Lecture note 6
	23	Comparison between SI and CI engines	

	24	Operating Variables That Affect Engine Performance	
9	25	Supercharging and Turbocharging	
	26	Hybrid Powertrain Architecture Introduction	Lecture note 7
	27	Hybrid Powertrain Performance - Series architecture	Lecture note 7
10	28	Hybrid Powertrain Performance - Parallel architecture	Lecture note 7
	29	Hybrid Powertrain Performance - Other architectures	Lecture note 7
	30	Hybrid Power System Components - Motor / Generator	Lecture note 7
11	31	Hybrid Power System Components - DC-DC Converter and Inverter	Lecture note 7
	32	Hybrid Power System Components - Regenerative Breaking	Lecture note 7
	33	Hybrid Power System Components – Battery	Lecture note 7
12	34	Hybrid Powertrain Energy Management	Lecture note 7
	35	Vehicle Power System Comparison	Lecture note 7
	36	Future Research on Hybrid Powertrain	Lecture note 7
13	37	Summary and Revision	

<b>ASSESSMENT</b>
-------------------

- Five assignments will be provided. The full mark for each assignment is 10 points. The average marks of the assignments will count as 10% of the overall score.
- Midterm 1 will cover the content of the first 9 lectures and count as 25% of overall score.
- Midterm 2 will cover the content of the lectures from 10 to 18 and count as 25% of overall score.
- Final exam will cover the entire course content and count as 40% of overall score.

<b>ACCREDITATION LEARNING OUTCOMES</b>
--

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Graduate Attributes	Learning Objectives where it is measured
---------------------	--

Knowledge base for Engineering (Indicator 4)	1,2,3,4,6
Problem Analysis (Indicator 2)	5,7

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

#### EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

#### PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

#### 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-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

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

#### 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.

#### COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students' responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.

#### SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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".

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:**
  - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
  - Students may submit requests for relief using the MSAF once per term.
  - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
  - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
  - The MSAF cannot be used for academic work that has already been completed attempted.
  - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
  - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.
2. **For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:**
  - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
  - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

#### 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, A2L and/or McMaster email.