McMaster University | ENGINEERING
W Booth School of Engineering Practice and Technology

Course Outline

1. COURSE INFORMATION

Session Offered	Winter 2024	
Course Name	Internal Combustion Engines	
Course Code	SEP 6AT3	
Date(s) and Time(s) of lectures	Wednesday, 14:30 – 15:20 Thursday, 15:30 – 17:20 January 11 – April 12, 2023	
Program Name	Automotive and Vehicle Engineering Technology	
Calendar Description	Internal combustion engine operating characteristics; engine maps; engine cycles; engine configuration and design; air and fuel induction; fluid motion within combustion chamber; heat transfer in engines; friction and lubrication.	
Instructor(s)	Lecture: Dr. A. Ghobeity, P.Eng. Lab: George Apostol	E-Mail: Avenue mail Office Hours & Location: by appointment

2. COURSE SPECIFICS

Course Description

Engine operating characteristics: work, pressure, torque, power, air-fuel ratio, fuel consumption, efficiency, emission. Engine cycles: air standard, Otto, Diesel, dual, two-strokes. Air fuel induction: volumetric efficiency, valves, injection, supercharging and turbocharging for SI, CI and two-stroke engines. Fluid motion within combustion chamber: turbulence, swirl, squish, tumble, crevice, blowby. Heat transfer: energy distribution, engine temperatures, heat transfer in intake system, combustion chamber and exhaust system. Friction and lubrication: Engine friction, forces on piston, engine lubrication system. Labs have been designed with respect to failure analysis, and cause/effect relationships.

Instruction Type

Code	Type	Hours per term
C	Classroom instruction	37
L	Laboratory, workshop or fieldwork	12
T	Tutorial	
DE	Distance education	
	Total Hours	49

Resources

ISBN	Textbook Title & Edition	Author & Publisher
ISBN-10: 0131405705 ISBN- 13 9780131405707	Engineering Fundamentals of the Internal Combustion Engine, 2nd Ed.	Willard Pulkrabek Pearson - Prentice Hall

Other Supplies	Source

Prerequisite(s)	
Course Specific Policies	The course includes a lecture component and a lab component. The lab component is mandatory: a student who does not attend a lab will not get the corresponding lab mark. All materials submitted after a deadline will not be assessed or reviewed
Departmental Policies	Students must maintain a GPA of 3.5/12 to continue in the program. In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of "out-of-class" work for every scheduled hour in

	class. "Out-of-class" work includes reading, research, assignments and preparation for tests and examinations. Where group work is indicated in the course outline, such collaborative work is mandatory. The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception. Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class. The instructor has the right to submit work to software to identify plagiarism.	
3. SUB TOPIC(S)		
Jan. 11 – 12	Introduction ○ Early history ○ Engine classification ○ Engine components ○ Basic engine cycles Engine operating characteristics ○ Engine parameters ○ Work ○ Mean effective pressure ○ Torque and power	Chapter 1 Chapter 2
Jan. 18 – 19	*Quiz #1* Engine operating characteristics ○ Dynamometers ○ Air-fuel ratio ○ Specific fuel consumption ○ Efficiencies ○ Emissions ○ 42-volt electrical systems	Chapter 2
Jan. 25 – 26	*Quiz #2* Engine cycles ○ Air standard cycles ○ Otto cycle ○ Diesel cycle	Chapter 3
Feb. 1 – 2	*Quiz #3* Engine cycles ○ Applications	Chapter 3
Feb. 8 – 9	*Quiz #4* Engine cycles ○ Dual cycle ○ Real air-fuel engine cycles	Chapter 3
Feb. 15 – 16	Review and term test ○ Review ○ *Term Test #1 (Thursday, Feb 15)*	Chapters 1, 2, 3
Mid-term Recess: Monday, February 20 to Sunday, February 26, 2023		
March 1 – 2	*Quiz #5* Air and fuel induction	Chapter 5

	○ Intake manifolds ○ Volumetric efficiency of engines ○ Intake valves ○ Fuel injection ○ Supercharging and turbocharging ○ Intake for two-strokes engines ○ Intake for CI engines Fluid motion within combustion chamber ○ Turbulence, swirl, squish and tumble ○ Divided combustion chambers ○ Crevice and blowby	Chapter 5 Chapter 6
March 8 – 9	*Quiz #6* Heat transfer in engines ○ Energy distribution ○ Engine temperatures ○ Heat transfer in intake system	Chapter 10
March 15 – 16	*Quiz #7* Heat transfer in engines ○ Heat transfer in combustion chambers ○ Heat transfer in exhaust system	Chapter 10
March 22 – 23	Review and term test ○ Review ○ *Term Test #2 (Thursday, March 21)*	Chapters 3, 5, 6, 10
March 29 – 30	*Quiz #8* Heat transfer in engines ○ Effect on engine operating variables on heat transfer	Chapter 10
April 5 - April 6	*Quiz #9* Friction and lubrication ○ Mechanical friction and lubrication ○ Engine friction ○ Forces on piston ○ Journal bearings	Chapter 11
April 12	Review	

Classes end: Wednesday, April 12, 2023
Final examination period: Monday, April 14 to Saturday, April 29, 2023
All examinations MUST BE written during the scheduled examination period.

List of lab experiments and lab tests	
Lab #1	Cylinder combustion integrity: compression test
Lab #2	Cylinder leakage and cooling system
Lab #3	Fuel injection system
Lab #4	Lab quiz
Lab #5	Engine valve timing and cam profile
Lab #6	Variable valve timing systems: VTEC and VVTI

Note that this structure represents a plan and is subject to adjustment term by term.
The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification

becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING *including dates*	Weight
Term Test #1 (February 15, 2024) - problems	10%
Term Test #2 (March 21, 2024) - problems	10%
Theory quizzes – Thursdays (see *SUB TOPIC(S)* for dates)	10%
Laboratory experiments: lab reports, lab test	15%
Case study (April 10, 2024)	20%
Final examination (tests cumulative knowledge: theory and problems)	35%
TOTAL	**100%**

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

1. Analyse the operating characteristics of internal combustion engines
2. Develop mathematical models to assess the operating characteristics of internal combustion engines
3. Compare engine cycles using mathematical models and determine their parameters
4. Describe the processes that take place in the intake system of engines
5. Evaluate heat transfer in the intake system, combustion chamber, and exhaust system of engines
6. Explain the effect of friction in combustion engines and describe lubrication
7. Apply experiential learning skills to analyse and describe operational characteristics of engines

6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS

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 https://secretariat.mcmaster.ca/app/uploads/Discrimination-and-Harassment-Policy.pdf

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/app/uploads/Academic-Integrity-Policy-1-1.pdf

The following illustrates only three forms of academic dishonesty: 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 https://www.mcmaster.ca/academicintegrity/turnitin/instructors/index.html

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.

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.

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, Teams 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 https://secretariat.mcmaster.ca/app/uploads/Academic-Accommodations-Policy.pdf

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".

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
https://secretariat.mcmaster.ca/app/uploads/2019/02/Academic-Accommodation-for-Religious-Indigenous-and-Spiritual-Observances-Policy-on.pdf

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.