



MECH 478 / 578

Internal Combustion Engines

2015W2 Course Syllabus

Monday, Wednesday, Friday: 1:00pm – 2:00pm, Forest Sciences Center (FSC) 1003

Instructor

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COURSE MATERIALS ARE AVAILABLE ON CONNECT (connect.ubc.ca)

Course Outline

1. Introduction
 - 1.1. Engine types and configurations
 - 1.2. History of engines, modern developments
 - 1.3. Challenges facing internal combustion engines
2. Review of Relevant Thermodynamics and Combustion Chemistry
 - 2.1. 1st law, modes of heat transfer, gas properties
 - 2.2. Equilibrium, stoichiometry, chemical kinetics, Arrhenius rate
 - 2.3. Fuel chemistry
 - 2.4. Emissions
 - 2.5. Engine performance metrics
3. Spark Ignition Engines
 - 3.1. Operating principle, standard cycles
 - 3.2. Combustion in SI engines, knocking
 - 3.3. SI engine emissions and emission control
 - 3.4. Control of SI engines, effect of throttling
4. Compression Ignition (Diesel) Engines
 - 4.1. Operating principle, cycles
 - 4.2. Combustion in diesel engines
 - 4.3. Diesel engine emissions and emission control
 - 4.4. Control of CI engines
5. Additional topics (flexible)
 - 5.1. Turbo/supercharging
 - 5.2. Alternative engine cycles (xCCI, GDI, stratified, downsizing)
 - 5.3. Alternative fuels



Course Objectives

This course will provide students with a technical introduction to internal combustion engines and an overview of the current state of the art engine and emission control technologies. Students will apply engineering fundamentals (primarily thermodynamics, chemistry, and fluid mechanics) to the analysis and interpretation of modern reciprocating internal combustion engines. The factors governing engine design decisions will be discussed, as will alternative thermodynamic, combustion, and fuelling strategies.

Evaluation Criteria

Students will be evaluated on their ability to apply engineering fundamentals to the analysis of internal combustion engines and their demonstrated understanding of the current state of the art in engine technology and future trends. Assignments will include design-type questions to assess these abilities. Students are strongly encouraged to complete all assignments, as the numerical tools (e.g. Matlab or Excel) developed in earlier assignments are needed for later assignments.

Students enrolled in MECH 578 will complete a term project including a report and presentation focussing on a topic relevant to internal combustion engines. This topic can be assigned by the instructor or proposed by the student (pending instructor approval). Exams and assignments will be slightly different for 478 and 578.

Grade Weighting

MECH 478

Assignments (4-5)	30%
Midterm	30%
Final	40%

MECH 578

Assignments (4-5)	15%
Project and presentation	15%
Midterm	30%
Final	40%

Textbook

The textbook for MECH 478/578 will serve primarily as a reference for assigned reading and background information to complement in the in-class notes. Either of the two textbooks listed below can be used for the course and a reading list will be provided for both:

Internal Combustion Engine Fundamentals. John Heywood. McGraw Hill, 1988

Available in bookstore (may be listed under MECH 410N). This is an excellent reference for engines and is strongly recommended; however, it is expensive (\$324!)

OR

Introduction to Internal Combustion Engines. Richard Stone. Macmillan Press, 2012

Available online at <http://books.sae.org/book-r-391/>

\$US 120-140 with shipping (depending on SAE membership status), group order discounts available.

In addition, a thermodynamics textbook will be helpful for reference and property tables (e.g., Thermodynamics: An Engineering Approach. Y. Çengel and M. Boles. 7th edition).

Additional references and readings will be provided throughout the term, either as handouts or as sections in online textbooks available through UBC libraries. To access these, you will need to be on campus or connected to the UBC network via VPN.

Plagiarism and Misconduct

All suspected instances of plagiarism, cheating or misconduct will be treated as outlined in the official University of British Columbia policy:

<http://vpacademic.ubc.ca/integrity/ubc-regulation-on-plagiarism/>



You should be familiar with the definitions and consequence of academic misconduct. The act and consequences of such are a waste of time for all parties involved.

Late Policy

Assignments are due at the beginning of class on the due date. After this, the following penalties will apply: -10% if received by the end of the day, -25% if received one day after due date, -50% if received two days after due date. Assignments received three or more days after due date will not be graded. Late assignments will be excused, or extensions granted for special circumstances (medical reasons, emergencies, etc.) if requested well in advance of the due date.

Additional References

These references are provided for additional reading if you are so inclined. They are not required for MECH 478/578 but will be useful in providing more information than is possible during the lectures. This is by no means an exhaustive list but will provide you with a starting point for finding additional information.

- Combustion Engines Development: Mixture Formation, Combustion, Emissions and Simulation. Günter P. Merker, Christian Schwarz, Rüdiger Teichmann. 2012.
<http://link.springer.com/book/10.1007%2F978-3-642-14094-5#section=961643&page=1&locus=3>
A general textbook covering the development of modern engines
- Internal Combustion Engine Handbook - Basics, Components, Systems, and Perspectives. Richard van Basshuysen, Fred Schäfer. 2004.
http://app.knovel.com/web/toc.v/cid:kpICEHBCS1/viewerType:toc/root_slug:internal-combustion-engine-3/url_slug:internal-combustion-engine-3/
A comprehensive handbook covering a broad range of engine topics.
- Flow and Combustion in Reciprocating Engines. C. Arcoumanis, T. Kamimoto. 2009.
<http://site.ebrary.com/lib/ubc/docDetail.action?docID=10313458>
Deals with the flow and combustion processes within the cylinders of engines.
- Handbook of Diesel Engines. K. Mollenhauer, H. Tschöke. 2010.
<http://link.springer.com/book/10.1007/978-3-540-89083-6/page/1>
A textbook dealing with modern diesel engines, including peripheral systems
- Charging the Internal Combustion Engine. H. Hiereth, P. Prenninger. 2007.
<http://link.springer.com/book/10.1007/978-3-211-47113-5/page/1>
Focuses on super- and turbocharging internal combustion engines.
- An Introduction to Engine Testing and Development. R. Atkins. 2009.
http://app.knovel.com/web/toc.v/cid:kpAIETD006/viewerType:toc/root_slug:an-introduction-engine/url_slug:an-introduction-engine/?
Provides information for developing and carrying out engine experiments.
- Mixture Formation in Internal Combustion Engines. C. Baumgartner. 2006.
<http://link.springer.com/book/10.1007/3-540-30836-9>
A dedicated text discussing in-cylinder mixture formation, an important topic for direct injection engines
- Introduction to Modeling and Control of Internal Combustion Engine Systems. L. Guzzella, C. Onder. 2010.
<http://link.springer.com/book/10.1007/978-3-642-10775-7/page/1>
A useful reference for understanding the underlying processes of engine control and the associated models. Some knowledge of control systems is needed.
- Vehicular Engine Design. K. Hoag. 2006.
<http://link.springer.com/book/10.1007/3-211-37762-X/page/1>
Provides guidance for the practical design of engine for vehicular applications.



- Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation. J. Warnatz, U. Maas, R. Dibble. 2001.
<http://link.springer.com/book/10.1007/978-3-662-04508-4/page/1>
A concise introduction to combustion theory, with some examples linked to engines.
- Combustion. I. Glassman. 2006.
<http://site.ebrary.com/lib/ubc/docDetail.action?docID=10216698>
A comprehensive reference for combustion fundamentals.
- Biodiesel: Production and Properties. A. Sarin. 2012.
<http://site.ebrary.com/lib/ubc/docDetail.action?docID=10655136>
An overview of the production and use of diesel fuel derived from biological (plant) sources.