

MIE516
COMBUSTION AND FUELS

Instructor

Prof. Murray Thomson, Room 335 Mech. Eng. Building, murray.thomson@utoronto.ca

Teaching Assistants

- Mehdi Salakhi mehdi.salakhi@mail.utoronto.ca
- Luke Di Liddo luke.diliddo@mail.utoronto.ca

Course Website:

On **Quercus**

Required Text

The required text is:

- “An Introduction to Combustion”, 3rd edition by S.R. Turns (or ISE 4th edition)

This book has been placed on 24-hour reserve in the Engineering Library. Note that the computer diskette software that goes along with this text can be downloaded from the library using the library book catalogue.

Supplemental Reading:

In addition, the following books are useful for the course:

- *Combustion*, 4th Edition by I. Glassman (an e-book of the fourth edition is available through the library for free) <http://simplelink.library.utoronto.ca/url.cfm/71033>
- *Applied Combustion* by Keating (2007)

Lectures:

Lectures will be at 5-6pm on Monday, Wednesday, Thursday GB244.

Tutorial: Thursday at 9:05 to 10:00 in HA401; They will occur in support of Assignments, midterm, finals and will be announced via emails and in class.

Office Hours:

In the past, I have found that it is most effective to answer questions at the end of the lecture time. I will stay after class until all questions are answered. In addition, I have office hours in my (MC335) Wednesday from 4-5pm.

Alternatively, you can also post questions through **Piazza**. Piazza is a Q&A and discussion board software tool. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Find our class page through Quercus website, Piazza tab. See:

- <https://www.youtube.com/watch?v=2jLSiN8E18w>
- <https://www.youtube.com/watch?v=QzpXEDVYrNk>

If none of this works, you can also email to arrange a meeting or call. If you email me, please include course code in subject line of email.

Grading

There will be four assignments of equal value, one midterm and one final examination. The exams will be type C with one aid sheet allowed. The aid sheet must use the template given on this website: <https://undergrad.engineering.utoronto.ca/wp-content/uploads/2016/06/Examination-Aid-Sheet-0215.pdf>

Only non-programmable electronic calculators will be allowed (type 2).

Here is the weighting scheme for calculating the final grade:

Assignments	20%
Midterm Exam	30%
Final Exam	50%

Midterm:

Dy-Mon-Yr	Bld/Room	Start	End	Building Name
24-OCT-24	RW 140	17:00	19:00	Ramsay Wright Laboratories

Assignments

1. Assignment due on **Thursday** at the **START** of class as are shown on the schedule
2. Solution sets are given out for the assignments and the midterm.
3. No late assignments!
4. Regarding collaboration: The work you submit is to be your own. If, after making an attempt at solving a problem you are stuck, you may consult the T.A. or instructor. You may also talk over the problem with other students in the class. But you may not examine the written work of another student. This rule is designed to reflect the situation you will most likely face in professional practice: there will be experts with whom you can consult on tough or new aspects of a problem, but ultimately, you will be expected to make independent contributions to the solution.

Course Structure

- Tools
 - Conservation of mass
 - Combustion stoichiometry
 - Ideal Gas Law
 - Conservation of Energy
 - Chemical Equilibrium
 - Chemical Kinetics

- Applications
 - Fuels
 - Gaseous Fuels
 - Liquid Fuels
 - Solid Fuels
 - Flames/Reactors
 - Plug flow Reactors
 - Premixed flames
 - Non-premixed Flames
 - Well stirred Reactors
 - Emissions
 - CO₂
 - NO_x
 - Particulate matter
 - CO
 - Unburned Hydrocarbons
 - Devices
 - SI engines
 - CI engines
 - Gas Turbine engines
 - Thermal Oxidation

Lecture Topics and Text Chapters

1. Introduction; Motivation; Discuss fuel issues of today	IC 1
2. Conservation of mass, stoichiometry	IC 2
3. Stoichiometry, equivalence ratio, applications to CO ₂ emissions	IC 2
4. Conservation of energy, Product Temperature	IC 2
5. Conservation of energy, Heat of combustion, Heating Value	IC 2
6. Conservation of energy, Adiabatic flame temperature	IC 2
7. Gaseous Fuels	IC 17
8. Chemical equilibrium	IC 2
9. Chemical equilibrium, pressure effect,	IC 2,
10. Solid Fuels	IC 17
11. Stoichiometry of practical fuels, naming conventions	AC6, IC17
12. Chemical kinetics	IC 4
13. Chemical kinetics	IC 4
14. Hydrocarbon Mechanisms	IC 5
15. Thermal destruction, Plug Flow Reactor	IC 6
16. NO _x formation	IC 4,5
17. NO _x formation	IC 4,5
18. NO _x Emissions	IC 15
19. Liquid Fuels	IC 17
20. Premixed Flames	IC 8
21. Laminar Premixed Flames	IC 8
22. Laminar Premixed Flames	IC 8`
23. Laminar Premixed Flames	IC 8
24. Emissions from Premixed Combustion	IC 15
25. Flame Stabilization, Blowout limits	IC 6
26. Flame Extinction/well stirred reactor	IC 6
27. Well stirred reactor problems	IC 6
28. Ignition, Constant Pressure Reactor	IC 6
29. Ignition, Constant Pressure Reactor	IC 6
30. Laminar Diffusion Flames	IC 9
31. Laminar Diffusion Flames	IC 9
32. Droplet Burning	IC 15
33. Droplet Burning/Emissions from Non-Premixed Combustion	IC 15/10
34. Combustion in Compression Ignition Engines	

Notes:

IC5: This means that further information on this section is available in the “An Introduction to Combustion” text in chapter 5.

AC7: This means that further information on this section is available in the “Applied Combustion” text in chapter 7.

Lecture and Assignment Schedule

Week	Monday	Wednesday	Thursday	Tutorials	Assignments
1		1	2		
2	3	4	5	1-4	1 Given
3	6	7	8	CL	
4	9	10	11	5-10	
5	12	13	14	10-13	(Oct 3) 1 Due 2 Given
6	15	16	17	CL	
7	Holiday	18	19; Midterm Review	14-18	(Oct 17) 2 Due
8	20	21	Midterm	Q&A	3 Given
9	Study Break	Study Break	Study Break	Study Break	Study Break
10	22	23	24	CL	
11	25	26	27	19-26	(Nov 14) 4 Given 3 Due
12	28	29	30	27-29	
13	31	32	33	30-32	(Nov 28) 4 Due
14	34	Final Review			

CL: There will be ANSYS/CHEMKIN tutorials during the tutorial to introduce you to the software "Chemkin" (<http://www.ansys.com/products/fluids/ansys-chemkin-pro>):

Dy-Mon-Yr	Bld/Room	Start	End	Building Name
19-SEP-24	MY 030	9:00	10:00	Myhal Centre MCEIE
10-OCT-24	MY 030	9:00	10:00	Myhal Centre MCEIE
07-NOV-24	MY 030	9:00	10:00	Myhal Centre MCEIE