ENGG*4820
Atmospheric Emission Control: Combustion Systems
Winter 2017

School of Engineering

(Revision 2: Jan. 8, 2017)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: William David Lubitz, Ph.D., P.Eng.
Office: THRN 1340, ext. 54387
Email: wlubitz@uoguelph.ca
Office hour: By appointment

1.2 Lab Technician

Technician: Joanne Ryks
Office: THRN 1114, ext. 54087
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1.3 Teaching Assistants

GTA	Email
None	

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4820 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

The primary text for this course will be:

Flagan, R. C. and Seinfeld, J. H. 1988. Fundamentals of Air Pollution Engineering. Prentice-Hall, Englewood Cliffs, New Jersey, U.S.A.

An electronic version is posted on Courselink, and alternatively can be downloaded from http://authors.library.caltech.edu/25069/1/AirPollution88.pdf

Newer versions of this text, such as the edition used in ENGG*4810, are also acceptable.

2.3 Recommended Resources

Some material and ideas from the following text will be used in the course. It is not required that students possess a copy of this text, but you may wish to consider purchasing it for your library if you intend to pursue further studies or a career in air pollution engineering.

Cooper, C. D., Alley, F. C. 2011. *Air Pollution Control: A Design Approach.* 4th Ed. Waveland Press, Prospect Heights, IL, USA.

2.4 Additional Resources

Lecture Information: Some lecture notes and supporting material will be posted on Courselink, generally before the specific lecture. Note that posted notes may be incomplete, prepared with the intention that students will take additional notes during lectures.

Lab Information: Requirements will be posted on Courselink.

Project Information: Requirements will be posted on Courselink

Assignments: Posted on Courselink.

Tests: Example questions drawn from past tests will be posted on Courselink.

Miscellaneous Information: Other information will be posted on Courselink.

2.5 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly.** As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

3 ASSESSMENT

3.1 Dates and Distribution

Assessment Submission	Submission format	Contribution to Total Course Mark	Due Date
Writing Project Phase 1	HTML files	5%	Sat. Jan. 21 at 12:00 noon. Submit files to your folder on the shared drive AND submit files to Courselink Dropbox.
Writing Project Phase 2	HTML files	5%	Sat. Feb. 4 at 12:00 noon. Submit files to your folder on the shared drive AND submit files to Courselink Dropbox.
Lab 1 - Engine system energy and mass balance	Lab Report	15%	Sat. Feb. 11 at noon. Submit via Courselink Dropbox
Midterm exam	Written exam	15%	Mon. Feb. 27 during lecture period
Lab 2 – Combustion Model	Code evaluated during tutorial	15%	In tutorials on Mar. 2 or 3. Submit files to Courselink Dropbox prior to start of tutorial.
Writing Project Phase 3	HTML files	10%	Sat. Mar. 18 at 12:00 noon. Submit files to your folder on the shared drive AND submit files to Courselink Dropbox.
Lab 3 - Engine system emissions experiment	Lab Report	20%	Sat. Mar. 25 at noon. Submit via Courselink Dropbox
Final exam	Written exam	15%	TBD during final exam period

Exams will be closed book. An 8½" by 11" student-generated aid sheet will be permitted. The exam will include some data tables and other reference information. This material will be posted on Courselink prior to each exam.

Labs 1, 2 and 3 will be completed in teams from your section. Teams will consist of 3 students (with 4th students added to groups as needed due to section enrollment).

3.2 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. Please see below for specific details and consult the undergraduate calendar for information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: The passing grade for this course is 50%. Students must also achieve a 50% or greater mark on the individual components of the course (writing project and exams) to pass the course. If the mark for the individual components, weighted as above, is less than 50%, than this mark will be recorded as the student's course mark, even if the course mark including group components is higher (or greater than 50%).

Missed exams: If you miss a test due to grounds for granting academic consideration or religious accommodation, the instructor will determine a makeup that will be scheduled at a time suitable for all individuals involved.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab. If you do not complete the pre-lab safety quiz, you will not be permitted to complete the lab. Students who miss laboratories and are not granted accommodation will receive a mark of zero for the project associated with the lab, regardless of the mark received by other group members.

Late Lab Reports: Late (> 4 hours) submissions will be penalized if there are not acceptable compassionate or medical grounds. A 30% penalty will be applied for reports submitted between 4 and 72 hours late. Reports received more than 72 hours late will be assigned a grade of zero.

Team Work: Team work is required for the lab assignments. If there is some observation or evidence that you have not made significant contributions to the work then you will be asked to provide evidence of your individual efforts, contributions and results. Keeping a log book may be one effective means to help demonstrate your contributions.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

Combustion systems are an essential part of our society, however, they are also the dominant source of atmospheric pollutants. This course will focus on investigation of combustion systems for the purpose of reducing atmospheric emissions.

Prerequisite(s): ENGG*2560 Environmental Engineering Systems, ENGG*3260 Thermodynamics

Corequisite(s): ENGG*3430 Heat and Mass Transfer

Restriction(s): ENGG*4330 Air Pollution Control (predecessor course)

4.2 Course Aims

This course aims to have students think deeply about energy systems involving combustion and their corresponding atmospheric emissions, and to critique emissions control technologies and identify opportunities for improvement.

These aims will be pursued through experimental and theoretical investigation, advancing fundamental process engineering, fluid mechanics and thermodynamics principles. Thus, the course also aims to enhance student's foundational skills which have value well beyond the atmospheric pollution domain.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. **Analyze** thermodynamic models of combustion systems for the estimation of emissions and system performance
2. **Develop** computer-based models to execute thermodynamic models
3. **Critique** models of combustion systems for the estimation of emissions and performance
4. **Analyze** conventional air pollution control technologies
5. **Plan and execute** experimental investigations to test hypotheses
6. **Summarize** the mechanisms of the greenhouse effect and fugitive emissions
7. **Research and Communicate** historical and background information relevant to air pollution

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 3, 4, 6	Exams, Projects
2. Problem Analysis	1, 2, 3, 4, 5	Exams, Labs 2 and 3
3. Investigation	3	Exams, Labs
4. Design	5	Lab 3

5. Use of Engineering Tools	2, 4	Lab 3
6. Communication	3, 5, 7	Writing Project, Labs
7. Individual and Teamwork	1, 2, 3, 5	Labs
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	-	-
11. Business & Project Management	-	-
12. Life-Long Learning	7	Writing Project

4.5 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled lectures and tutorial periods will be the principal venue to provide information and feedback for tests and projects.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*2560: Mass balances around reactor systems including reaction kinetics and equilibrium

ENGG*2230: Transport and mixing processes are based on fluid mechanic principles

ENGG*3260: Energy and emissions dominantly build on thermodynamic principles

ENGG*3100: Continuing to advance your design skills is essential for air pollution control

ENGG*3180: Air quality sets the context for the atmospheric control challenges that ENGG*4820 addresses

ENGG*3430 & ENGG*3470: Heat and mass transfer limitations can play a significant role in the effectiveness of many air pollution control solutions

ENGG*3410: Automated control systems play an integral role in the operation and success of a very large fraction of emission control technology

Follow-on Courses:

ENGG*4130: Many final design teams and projects will draw on ENGG*4820 skills, directly benefitting teams addressing air pollution challenges in their design work.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Mon., Wed., Fri.		2:30 pm – 3:20 pm	MacNaughton 118
Labs/Tutorials:			
Section 01	Fri.	3:30 pm – 5:20 pm	THRN 1313, 1012
Section 02	Thurs.	3:30 pm – 5:20 pm	THRN 1004, 1012

- most weeks the labs/tutorials will be in THRN 1313/1004.

5.2 Lecture Schedule (approximate)

Week	Lecture Topics	References*	Learning Objectives
1 – 1/9	Introduction, Combustion Stoichiometry	Ch. 1, Sec. 2.1-2.2, notes	1, 7
2 – 1/16	Enthalpy, Adiabatic Flame Temperature	Sec. 2.3	1, 2, 3
3 – 1/23	Combustion Equilibrium	Sec. 2.3	1, 2, 3
4 – 1/30	Combustion Equilibrium, Reaction Kinetics	Sec. 2.3-2.4, notes	1, 2, 3
5 – 2/6	Reaction Kinetics	Sec. 2.4	
6 – 2/13	Flame Structure	Sec. 2.5-2.8	
7 – 2/20	*Reading Week*		
8 – 2/27	Midterm exam, NO_x	Ch. 3, notes	1, 2, 3
9 – 3/6	Internal Combustion Engines	Ch. 4	3, 4
10 – 3/13	Gaseous Pollutant Removal	Ch. 8	4
11 – 3/20	Incineration, VOCs	Cooper & Alley Ch. 11	1
12 – 3/27	Fugitive Emissions	Cooper & Alley Ch. 18, notes	6
13 – 4/3	Global Warming, Closure	Notes	6
4/10– 4/24	Final Exam Period		

* Chapters and Sections refer to Flagan and Seinfeld (1988) unless noted.

5.3 Lab / Tutorial Schedule (approximate)

Week & Dates	Topics	Locations
1. Jan 12/13	Background Recapture	THRN 1004/1313
2. Jan 19/20	Problem Sets, Lab Safety	THRN 1004/1313, THRN 1012
3. Jan 26/27	Problem Sets, Engine Lab 1	THRN 1004/1313, THRN 1012
4. Feb 2/3	Problem Sets, Engine Lab 1	THRN 1004/1313, THRN 1012
5. Feb 9/10	Problem Sets	THRN 1004/1313
6. Feb 16/17	Problem Sets, Midterm Review	THRN 1004/1313
7. Feb 23/24	*Reading Week – no labs/tutorials*	
8. Mar 2/3	Midterm exam returned and reviewed	THRN 1004/1313
9. Mar 9/10	Problem Sets, Engine Lab 2	THRN 1004/1313, THRN 1012
10. Mar 16/17	Problem Sets, Engine Lab 2	THRN 1004/1313, THRN 1012
11. Mar 23/24	Problem Sets	THRN 1004/1313
12. Mar 30/31	Problem Sets	THRN 1004/1313
13. Apr 6/7	Exam review	THRN 1004/1313

Note: some experiments may be conducted outside of the scheduled lab/tutorial contact hours.

5.4 Other Important Dates

Monday Jan. 9 – first day of class
Friday Jan. 13 – last day to add classes
Monday Feb. 20 to Friday Feb. 24 – Reading Week
Friday Mar. 10 – 40th class day last day to drop
Friday Apr. 7 – last day of class

6 LAB SAFETY

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

If the laboratory rules are not followed, consequences will include removing student's access to the lab. If this results in lab work not being completed, the student will receive a grade of zero.

A pre-lab safety quiz must be passed before students may complete labs. A group will not be permitted to complete a lab until all members of the group have individually passed the quiz. Students may be asked equivalent lab safety questions while in the laboratory. Students who cannot demonstrate a working knowledge of laboratory safety will be removed from the lab.

7 ACADEMIC MISCONDUCT

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

9 RECORDING OF MATERIALS

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: http://www.uoguelph.ca/registrar/calendars/index.cfm?index